TERRAIN INVENTORY
for the
Stikine-Iskut Area

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TERRAIN INVENTORY FOR THE STIKINE-ISKUT AREA

(NTS 104F, 104G and parts of 104B and 104H)

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1. INTRODUCTION

Terrain iventory for the Stikine - Iskut map area was carried out during July to December, 1982, as part of the Dease-Stikine Biophysical Project of the British Columbia Ministry of Environment. The results of this work are presented in maps of terrain materials and terrain features at a scale of 1:250 000 and in this report.

The terrain maps for the Telegraph Creek mapsheet (NTS 104G) were prepared by J. M. Ryder and those for 104F and parts of 104B and 104H by L. E. H. Lacelle. The material in this report was originally prepared by Ryder for 104G. Additional data to expand the coverage to include the remainder of the study area was provided subsequently by Lacelle.

The objectives of this report are twofold. It is intended to supplement the terrain maps by providing additional information about surficial materials, landforms, geological processes and hazards, and regional physiography. It is also intended to be a guide for map users, especially those who wish to interpret terrain data for general planning purposes.

It is anticipated, indeed it is strongly recommended, that persons using this report do so with the terrain maps, their legends, and standard N.T.S. maps of 104B, F, G, and H visible in front of them.

1.1 TERRAIN MAPPING

Terrain maps were prepared according to the Terrain Classification System (E.L.U.C.S., 1976). Persons unfamiliar with this method of terrain mapping should read carefully the explanation of letter notation that is given at the beginning of the terrain materials map legend (Box 1). All symbols and terms that have been used on the maps are listed and defined in the map legends and most of them are defined more fully in this report.

Persons familiar with this method will find that a few minor modifications to the 1976 system were made in order to use this system for 1:250 000 scale mapping and to describe the terrain of the Stikine - Iskut area. The most obvious change is the production of two maps, a "terrain materials map", which is a standard terrain map showing surficial materials, surface expression and geological processes but without on-site symbols, and a "terrain features map", which is a map of on-site symbols depicting landforms such as eskers, meltwater channels, cirques and landslides. Also, composite unit symbols have been simplified and a few new on-site symbols, for example volcanic cones, have been added.

In general, the style of mapping is such that terrain units (map polygons) are of relatively small areal extent, a reflection of the diversity of the natural landscape, and terrain unit symbols are relatively short and simple. This last advantage was gained by generalizing the surficial materials part of the map legend (Box 3). For example, the definition of bedrock allows up to one-third, by area, of colluvium. Thus, colluvium rarely needs to be indicated as a minor component of a bedrock area. Most composite terrain unit symbols consist of no more than two components. Longer symbols have been used only where the two-component restriction would have resulted in misleading simplification, and in these instances, a full description of the complex terrain unit is given in this report (Section 3.11).

1.2 MAPPING PROCEDURE

Terrain mapping was carried out by air photo interpretation and by field work. Black and white air photos at a scale of approximately 1:75 000 were used. (See Appendix A for air photo numbers.)

Preliminary air photo interpretation ("pretyping") was done before field work: all terrain units (map polygons) were outlined on the air photos and labelled with terrain unit symbols; terrain features (eg. land-

slides, cirques, eskers) were marked by on-site symbols. Sites requiring field checking were identified. These were chiefly terrain units that appeared to have unusual characteristics or exposures of surficial materials.

Field work was carried out during July and September: 18 days were spent traversing the area by helicopter, 9 days working along roads, and 5 days traversing on foot (with helicopter drop off and pick up). Observations were recorded at a total of 168 sites. Routes and observation sites are shown on Figure 1. Observation sites are also shown on the terrain features map. Vehicles and aircraft were shared with persons responsible for the other components of the biophysical survey - soils, vegetation, and wildlife - so that observation sites and routes were selected for multiple purposes rather than soley for investigation of terrain.

During field work with the helicopter, many observations were made from the air; in fact, more information about terrain was gained whilst airborne than whilst on the ground at the numbered observation sites. All major exposures of surficial materials (common along stream and river cutbanks, gullies, and slide scarps) were examined whilst either flying slowly across the sections or hovering. The materials comprising major stratigraphic units and their relative thicknesses could normally be identified by this procedure, although surface wash and minor sloughing sometimes partially obscured sections and prevented positive recognition of materials.

Many terrain units (probably more than half of the total number of map polygons) were also checked visually from the air. Above timberline, various materials and landforms can be easily distinguished. Below timberline, where helicopter landing sites are few and far between, terrain units were checked from the air by observing landforms, the general character of the ground surface (rock outcrops, boulders, rounded stones, excavations by animals, etc.), and searching along creeks and gullies for small outcrops of surficial material.

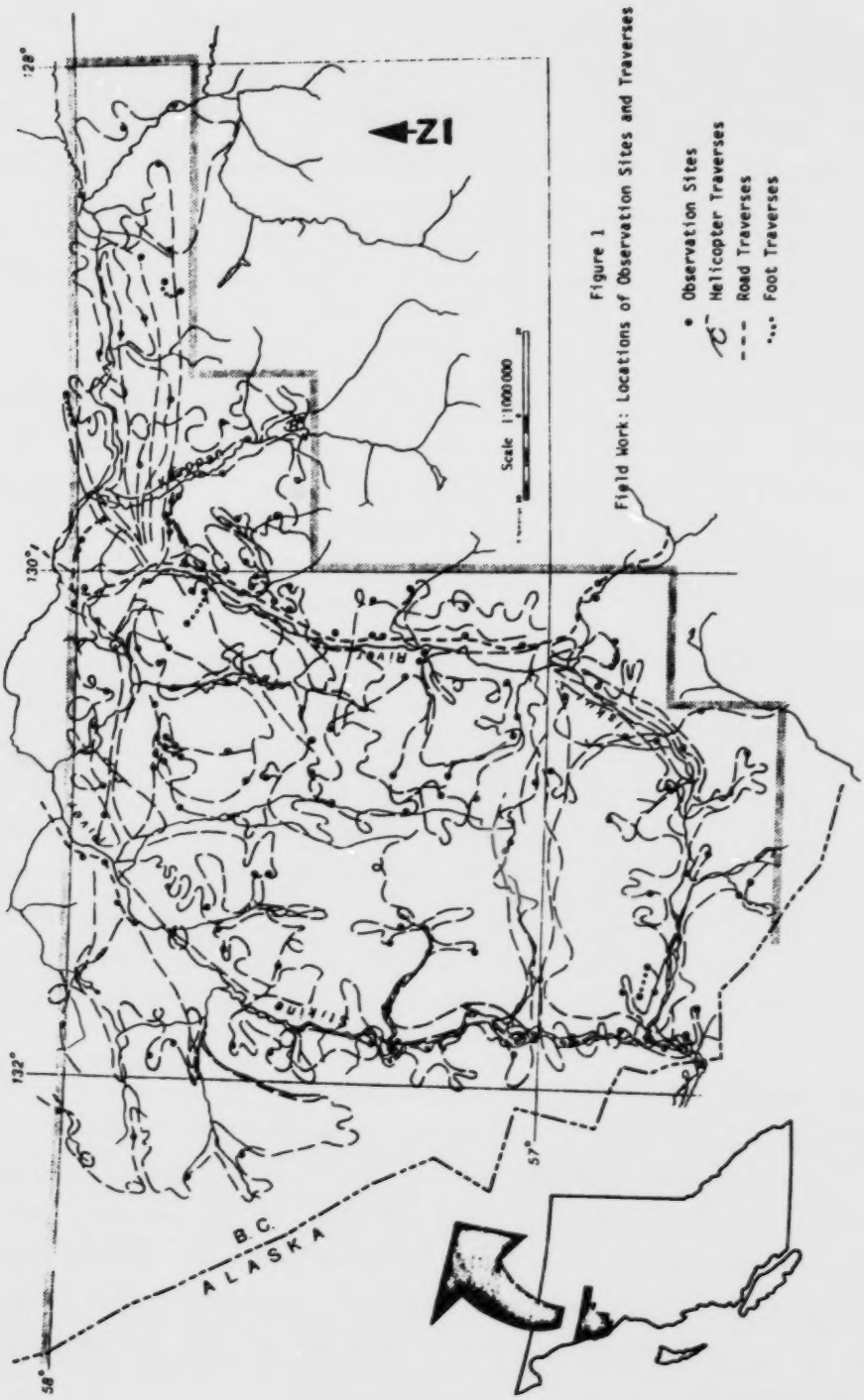


Figure 1
Field Work: Locations of Observation Sites and Traverses

Since it was often difficult to find helicopter landing sites in forested terrain units, many sites that should preferably have been checked by observations on the ground, were checked only from the air.

During field work along roads, all road cuts and gravel pits were examined. Since there are commonly many accessible sections within a terrain unit that is crossed by a road, this work provides a useful indication of the local variability of surficial materials in contrast to the information gained by "point sampling" with the helicopter.

Foot traverses also provided useful impressions of the local variability of terrain and allowed examination of detailed yet significant aspects of local geology, such as the distribution of erratics, striations, tors and periglacial landforms, the age of moraines, and thickness variations of surface materials.

Numbers were assigned to observation sites on roads and foot traverses only where particularly good or representative sections were found or where samples were collected.

Wherever possible, ground observation sites were located where surficial materials are exposed in cutbanks or gullies. However, due to constraints imposed by time, terrain conditions, landing sites, and the multipurpose objectives of the field party, many stops were made in atypical terrain and at sites where information about surfical material had to be gained from shallow hand-dug pits and from observation of land surface characteristics. Consequently no attempt was made to collect a standard data set at each observation site. Rather, whatever features were visible and seemed most significant at each place were recorded. For these reasons also, no site description forms were attempted. The information collected has been compiled, assessed for its representativeness and reliability, and reworked into the general descriptions and specific comments that comprise this report.

Only one of the common surficial materials - till - was sampled systematically for laboratory analysis (of till matrix) at ground observation sites, since till characteristics (particularly texture and related properties) can be so variable (Section 3.1). Glaciolacustrine sediments were sampled where accessible. For the purposes of reconnaissance inventories such as this study, sampling of other materials is either unnecessary, since they can be quite adequately described from field observations (fine gravels, sands), or impractical, because of the large sample sizes required (colluvium, gravel).

Following completion of field work, terrain unit boundaries, terrain unit symbols and on-site symbols that had been drawn previously on air photos were reassessed, modified where necessary, and finalized. Lines and symbols were then transferred from photos to the 1:250 000 scale topographic maps by hand and eye. Enough features can be recognized on both photos and maps, especially in a topographically irregular area such as this, to enable accurate transfer of information. In fact, whilst carrying out this close comparison of map and photo information, it was noticed that the map contour lines do not consistently represent the topography visible on the air photos. For example, small cirques and gullies are clearly shown by contour indentations in some areas, but are smoothed over or ignored elsewhere. The representation of icefields and glaciers is especially erratic, as will be seen if the extent of ice on the terrain materials maps is compared to that on the topographic map. (See further comment in Section 3.10 below.)

1.3 QUALITY OF TERRAIN MAPPING

Those parts of a terrain map that can be assessed for accuracy include:

(1) position of terrain unit boundary lines;

(2) the contents of the terrain unit symbol;

(3) position and usage of on-site symbols.

In general, their reliability will depend upon:

a) ability and experience of the mapper;
b) scale and quality (definition, contrast, snow and cloud cover) of air photos;
c) nature of terrain;
d) extent of forest cover and artificial disturbance of terrain, which usually hinders air photo interpretation;
e) length of time spent in the field;
f) availability of field access (chiefly roads);
g) number and extent of exposures of surficial materials;
h) availability and quality of previous work.

Any attempt to judge the quality of a terrain map is obviously a complex procedure. However, the following comments are offered with regard to the maps of Stikine - Iskut area.

The reliability of the terrain materials map can be evaluated in terms of terrain unit boundary lines and terrain unit symbols. In general, it is considered that line positions are reasonably accurate because: (1) many types of terrain in the Stikine - Iskut area (e.g. floodplains, plateaus, steep hillsides) are bounded by distinct breaks of slope that are sharply defined on air photos and easy to locate on the topographic map. (2) At this scale of mapping, lines are plotted from air photo interpretation anyway, and so would not be more precisely located even if much more time had been spent in the field. Also, the use of three types of boundary ('definite', 'indefinite or gradational' and 'assumed' - see terrain legend Box 6) indicates the mappers' opinion of the precision of each line.

The accuracy with which the contents of each terrain unit are described by the terrain unit symbol is more difficult to assess. In general, the mountainous parts of the Stikine - Iskut area appear to present no particular problems for mapping at this relatively small scale, aside from the usual vexing question of the relative proportions of till and colluvium on

moderate to steep forested slopes. This difficulty has been partially overcome by generalizations written into the map legend (See terrain legend Box 3 - e.g. "till on slopes is commonly overlain by thin ... colluvium ..."). Complex sets of surficial materials - thick sequences of till, glaciolacustrine sediments and glaciofluvial gravels of various ages and with cross-cutting structural interrelationships - may underlie some valley floors and lowlands, most notably the Morchuea Lake lowland (see Section 2.12) adjacent to Stikine River, parts of Iskut River valley west of Iskut River between Natadesleen Lake and the southern boundary of the map area (but not the rocky ridge or hummocky areas), Mess Creek valley north of its confluence with Raspberry Creek, and the valleys of Stikine and Kappan Rivers in mapsheet 104H. The terrain map is probably least accurate in these areas. Other comments regarding the reliability with which certain types of terrain are portrayed are given in Section 3 of this report.

The total time spent in the field (32 days) is considered by the mappers to be adequate for general reconnaissance of Stikine - Iskut area. Longer time (with helicopter) would have increased the reliability of the terrain maps, but at a diminishing rate. (A longer time per unit area - three to five times as long for similar terrain and access - is normally spent in the field for 1:50 000 scale terrain mapping.) A total of about 55 days was spent on air photo interpretation.

Information that is represented by on-site symbols on the terrain features map is considered to be relatively reliable: all of the features indicated are readily identifiable on air photos. The most obvious inadequacy of this map is that most relatively small features - particularly meltwater channels, eskers, moraines and small landslides - had to be omitted due to space restrictions on the 1:250 000 scale map. The classification of landslides that is given by letter symbols should be considered tentative, particularly the designations of landslide age.

2. GENERAL DESCRIPTION OF AREA: GEOLOGY AND PHYSIOGRAPHY

The Stikine - Iskut area spans the geological, physiographic, climatic and biotic transition that occurs between the coastal mountain ranges and the intermontane plateaus of British Columbia. Changes take place along a southwest - northeast trend:

The area is underlain by relatively old sedimentary and volcanic rocks that have been intruded by plutons of granitic rock. Plutons are largest and most closely adjacent in the western and southwestern part of the area and become smaller and scattered toward the east and northeast. During mid-Tertiary time, weathering and erosion formed a gently undulating land surface at relatively low elevation across all rock types. During late-Tertiary time the erosion surface was warped and ruptured by differential uplift and faulting. Uplift was greatest in the southern and western parts of the Stikine - Iskut area and least, although still substantial, toward the northeast. Downcutting by streams and rivers occurred in response to uplift. Erosion and valley development proceeded most rapidly where uplift had been greatest and where streams were steepest (and also relatively large due to their coastal location). Thus there evolved a gradation from rugged, mountainous topography in the south and west to dissected and less dissected plateaux in the east and northeast.

The volcanoes of Edziza, Spectrum Range, and Hoodoo Mountain, built by eruptions which have occurred since Tertiary times, are superimposed upon the old erosion surface.

During Pleistocene time, all of the Stikine - Iskut area was glaciated. Glacial erosion was most intense in the southern and western mountains where high land and heavy snowfall gave rise to extensive icefields and major valley glaciers. Permanent snow and ice still occupy large areas of these mountains today but become rarer northeastward, even at similar elevations, in response to the climatic transition between coast and interior.

This brief and drastically simplified history explains the broad physiographic features of Stikine - Iskut area. Holland's (1964) physiographic regions subdivide the area accordingly into Boundary Ranges of the Coast Mountains, Tahltan Highland, Skeena Mountains, Klastline Plateau and Spatsizi Plateau.

The physiographic regions defined by Holland (1964) are commonly used as a basis for the description of geological, geomorphological, and even pedological features! However, their application at 1:250 000 scale is inappropriate because they are too general, many boundary lines are meaningless, and within region variability is high. (They were originally published on a 1:2 million scale map.) Thus for present purposes, that is, for description of salient geological, topographic, and landform features, a different regional subdivision is proposed. This is shown in Figure 2. The areas are named informally: it is not the writer's intention to propose new geographical names. The comment in parentheses after each title refers to Holland's (1964) regions.

Readers should consult the standard N.T.S. maps for information about elevations and drainage patterns. Most of the information that is clearly visible on these maps is omitted from the following desriptions. Generalized bedrock geology is shown in Figure 3, which is derived from a 1:1 million scale map by Souther, Brew and Okulitch (1979). A more detailed account of the geology of Telegraph Creek area (104G) and a 1:250 000 scale geological map are provided by Souther (1972).

2.1 TAHLTAN LAKE PLATEAU (part of Tahltan Highland)

This is a severely dissected plateau that consists of small remnants of undulating upland surrounded by long, steep and irregular slopes. Plateau surfaces are the glaciated remnants of the Tertiary erosion surface. They bear a thin cover of mixed till and colluvium that consists of frost shattered local rock and occasional erratics. Isolated rock knobs protrude

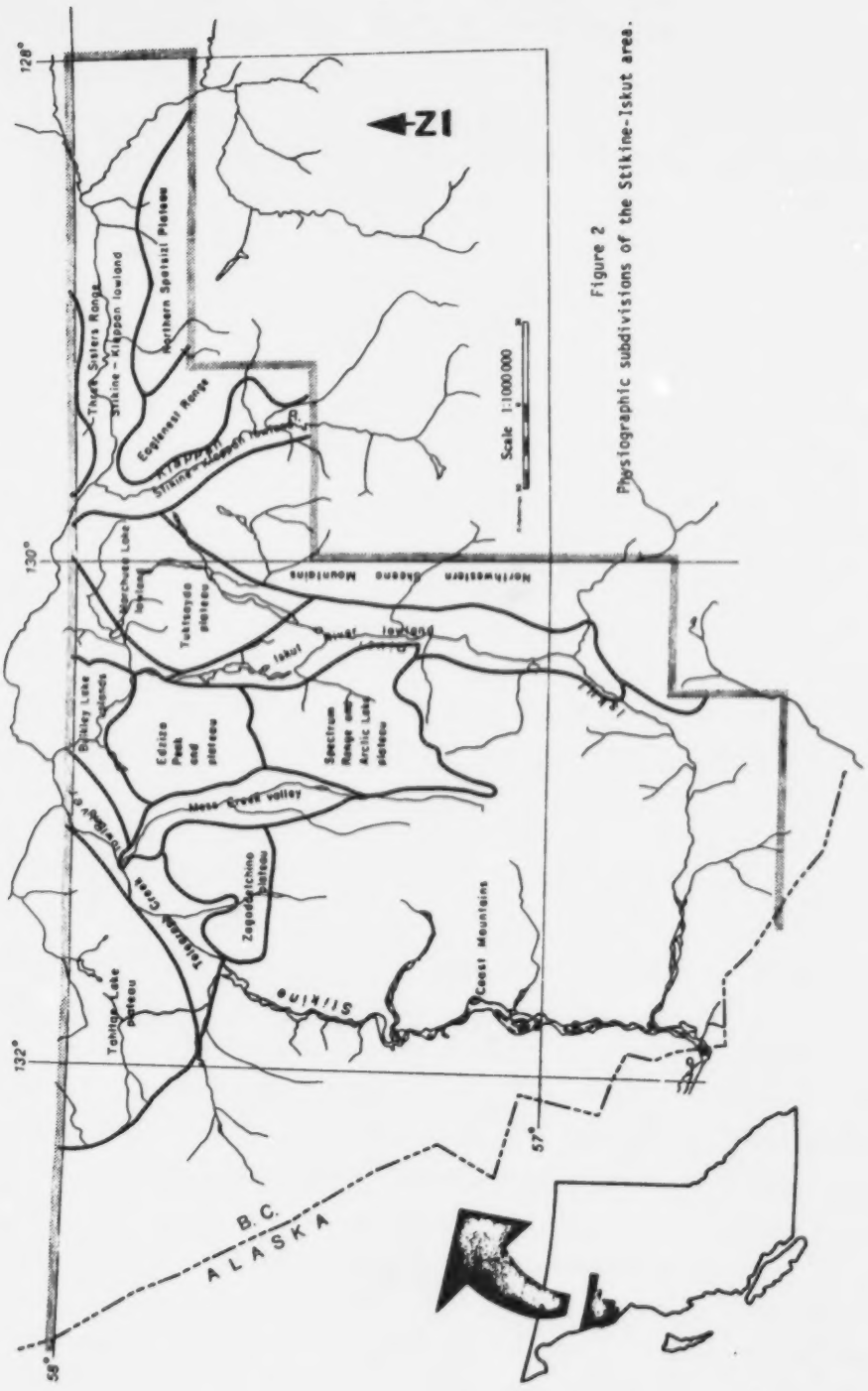


Figure 2
Physiographic subdivisions of the Stikine-Iskut area.

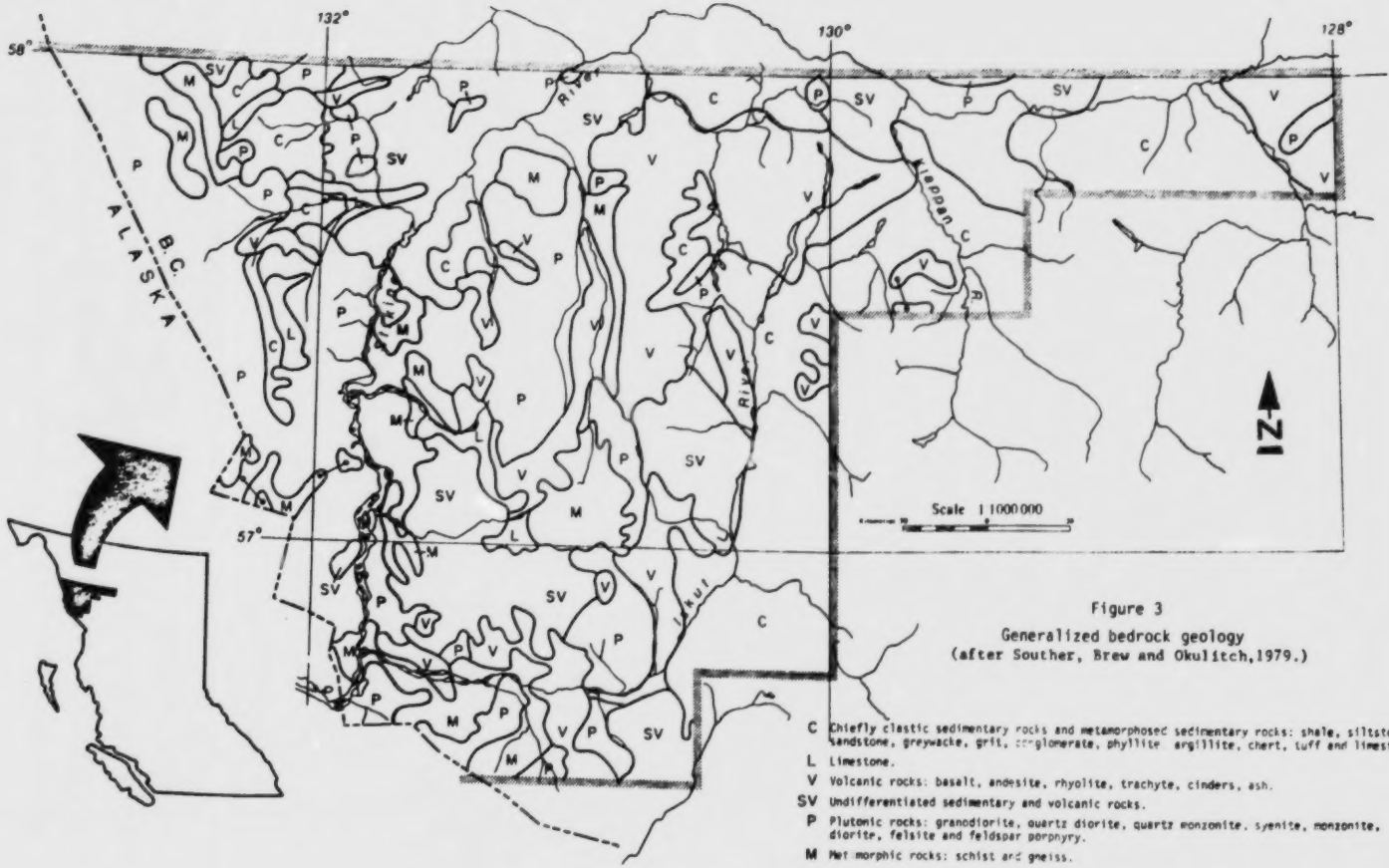

58°
132°
130°
128°
57°
ALASKA
B.C.
Stikine River
Klappan R.
Iskut River
Scale 1:1000000
C Chiefly clastic sedimentary rocks and metamorphosed sedimentary rocks: shale, siltstone, sandstone, greywacke, grit, conglomerate, phyllite, argillite, chert, tuff and limestone.
L Limestone.
V Volcanic rocks: basalt, andesite, rhyolite, trachyte, cinders, ash.
SV Undifferentiated sedimentary and volcanic rocks.
P Plutonic rocks: granodiorite, quartz diorite, quartz monzonite, syenite, monzonite, diorite, felsite and feldspar porphyry.
M Metamorphic rocks: schist and gneiss.

Figure 3

Generalized bedrock geology
(after Souther, Brew and Okulitch, 1979.)

through this mantle. The local landscape is dominated by the effects of solifluction, frost action (including patterned ground) and other periglacial processes.

A long, straight scarp that runs northeastward from the southern slope of Mt. Barrington to beyond Dodjatin Mountain is a particularly prominent feature. It rises abruptly for 1000 to 1300 m (3000 to 4500 feet) above the lowlands of Stikine River valley. North-facing scarps are nivated, and indented by cirques which typically contain small moraines and rock glaciers. A broad depression in the central part of this area (upper Barrington River to Tahltan Lake) is occupied by extensive areas of knobbly ice-abraided bedrock. Bedrock is upper Triassic sedimentary and volcanic rocks.

2.2 ZAGODDETCHINO PLATEAU (part of Tahltan Highland)

This is topographically similar to Tahltan Lake plateau but rises to higher summits. As a result, nivation and cirque glaciation have been slightly more severe, and small glaciers and permanent snowbanks presently occupy niches on the shady sides of the highest ridges. The area differs from Tahltan Lake plateau with regard to bedrock geology: its eastern two-thirds are underlain chiefly by granitic rocks, schist, and gneiss.

2.3 BUCKLEY LAKE UPLANDS (parts of Tahltan Highland and Klastline Plateau)

This area consists of gently sloping, till-covered terrain. Its continuity is broken by two scarp slopes with rock outcrops and colluvium: one faces northwest toward Stikine River, and the other, which is higher and steeper, faces south and southwest to Klastline River.

2.4 EDZIZA PEAK AND PLATEAU (part of Tahltan Highland)

Edziza Peak is the highest point on the rim of the large central crater of a composite volcano. The volcanic cone, which is now ice-covered, is

superimposed upon an older basaltic shield volcano, which constitutes the gently sloping Edziza plateau. Postglacial eruptions have built small cinder cones and spread extensive flows of blocky lava across the plateau surface and into adjacent valleys. The eastern and western margins of the Edziza plateau are prominent escarpments that have been formed by faulting and erosion, and modified by landslides. The thick sequence of near horizontal lava flows that comprises the shield volcano is spectacularly displayed in these cliffs. The plateau has been partially dissected by streams and the cone has been modified by glaciers. Erosion has been most effective along the steep eastern side of the complex where narrow ridge crests are all that remain of the plateau, and glacial erosion has breached the main crater of the volcano.

2.5 SPECTRUM RANGE AND ARCTIC LAKE PLATEAU (part of Tahltan Highland)

The geology of this area is similar to that of Edziza Peak and plateau. The basal shield volcano extends southward under the Spectrum Range and constitutes the adjacent plateau. The mountains consist of lava domes, thick stubby flows, and pyroclastic deposits. Alteration of volcanic rocks by gases and liquids during the final stages of vulcanism (Spectrum Range volcanoes have been inactive for much longer than Edziza) resulted in the bright colours for which the range is named. The central core of the Spectrum Range is dissected by shallow cirques and glacial valleys. The higher and steeper sides of present stream valleys have been modified by large landslides and other slope processes.

The prominent unnamed outliner of the Spectrum Range that lies between the Little Iskut and Iskut Rivers is an eastward-tilted block of older (Jurassic) lavas and related rocks. Small but well developed cirques have dissected and scalloped a rolling plateau surface. The most outstanding features of this range are its large rock glaciers and the juxtaposition of rock glaciers and sharp-crested moraines in adjacent cirques.

2.6 TUKTSAYDA PLATEAU (part of Klastline Plateau)

The topography of this dissected plateau is similar to that of Zagoddetchino plateau, although the plateau is more continuous. Glacial and periglacial features are well developed in the northern part of the area but absent further south where the plateau surface declines to relatively low elevations. The area is underlain by upper Triassic lavas with small areas of sedimentary rocks and a few minor plutons.

2.7 NORTHWESTERN SKEENA MOUNTAINS (part of Skeena Mountains)

The Skeena Mountains consist of interbedded conglomerate, grit, greywacke, siltstone and shale of Jurassic and Cretaceous ages. The Tertiary erosion surface, modified by glaciation and periglacial processes, here constitutes a gently rolling, dissected plateau that truncates folds in the sedimentary rocks and in places is capped by near horizontal lava flows. Small but regular cirques scallop the north and northeast-facing rims of the plateau. In the southern, slightly wetter part of this area glaciers are still present, cirques are larger and have entirely consumed some parts of the plateau.

2.8 COAST MOUNTAINS (part of Boundary Ranges of the Coast Mountains)

This area is characterized by steep and rugged glaciated topography, great range of relief, and the presence of numerous valley glaciers and icefields. The partially coalescing plutons which underlie this area consist of granodiorite, quartz monzonite, quartz diorite, with minor diorite, syenite, and porphyry. They are separated by remnants of the original sedimentary and volcanic rocks (now largely metamorphosed) into which intrusion occurred. Rock types seem to have little control upon the ruggedness or form of the topography; glacial erosion appears to have been the chief influence upon major landforms.

Rivers within the Coast Mountains typically occupy braided channels on broad plains of gravel and sand. Recent glacial recession has exposed fresh morainal areas, which are still largely unvegetated. Snow avalanches are probably the most widespread slope process; rockfalls commonly occur, but major landslides are rare.

2.9 TELEGRAPH CREEK LOWLAND (part of Tahltan Highland)

This area consists partly of glacially abraided rocky knobs and ridges and partly of gently undulating terrain on thick drift, including Fraser Glaciation till and glaciofluvial gravels underlain by older lacustrine sediments. River terraces and old river channels border the present course of Stikine River. Bedrock consists of upper Triassic volcanic and sedimentary strata.

2.10 MESS CREEK VALLEY (part of Tahltan Highland)

The floor of this fault-controlled valley has a thick covering of glacial drift, including till, glaciolacustrine sediments, and glaciofluvial gravels. Mess Creek and Schaft Creek have incised into the drift, and in places, into underlying bedrock. Landslides have occurred in both drift and bedrock along the sides of these small postglacial valleys. Sliding and slumping of bedrock are particularly active in the deep rock canyon of lower Mess Creek near Stikine River.

2.11 ISKUT RIVER LOWLAND (part of Skeena Mountains, Tahltan Highland and Klastline Plateau)

This lowland consists chiefly of ice-abraided rocky ridges. Like Stikine River lowland, it appears to have carried a major ice stream during glaciation. The strongly expressed linearity of glacially moulded rock knobs in this area has resulted from parallelism between ice flow direction and strike of interbedded hard and soft sedimentary rocks (the area is

underlain chiefly by the same rocks as the Skeena Mountains). Thick drift, including materials that predate Fraser Glaciation, occupies some bedrock depressions.

2.12 MORCHUEA LAKE LOWLAND (part of Klastline Plateau)

This area is distinguished by some of the lowest relief of the entire map area. It is swampy, poorly drained, and underlain by thick drift. Surface features, including gravelly ablation till, glaciofluvial sand and gravel, meltwater channels and small eskers, suggest that a mass of ice stagnated and melted here. Pre-Fraser Glaciation lacustrine sediments, that are exposed in the southern valleyside of Stikine River a short distance beyond the northern limit of map sheet 104G, may extend into this area.

2.13 EAGLENEST RANGE (part of Skeena Mountains)

In map area 104H the Eaglenest Range consists of large and small remnants of a plateau that has been dissected by large cirques, especially on north-facing slopes. Long, steep and irregular slopes are common. The plateau is underlain primarily by siltstone and graywacke. Its surface is generally veneered by frost shattered colluvium and rubbly till of a similar composition. Knobs of exposed bedrock are common. Periglacial features are commonly evident, except on lower northwestern parts of the plateau.

2.14 THREE SISTERS RANGE (part of Cassiar Mountains)

The Three Sisters Range extends for a short distance into map area 104H (Figure 2) as a highly dissected plateau characterized by numerous large cirques and through valleys. Rock glaciers are relatively common in large cirques. Only fragments of the original plateau surface remain, and long, steep and irregular slopes dominate the landscape. The upland surface has relatively low relief. There are some bedrock outcrops, but large areas are veneered by frost shattered colluvium and stony till. Volcanic and sedimen-

tary rocks underlie most of the Three Sisters Range in map area 104H. The predominantly quartz monzonite Hotailuh batholith extends into the northernmost portion of this physiographic subdivision.

2.15 NORTHERN SPATSIZI PLATEAU (part of the Spatsizi Plateau)

In this area, the continuity of the plateau surface is broken by numerous scarps (short and steep slopes), giving rise to a pronounced stepped topography. Gently undulating surfaces of low relief are veneered with till and gravelly colluvium derived from the underlying horizontally-bedded conglomerates. Patterned ground, solifluction features, and glacial meltwater channels are common. Landforms of glacial erosion such as deep through-valleys and cirques are less common here than on plateaux to the west and north.

2.16 STIKINE - KLAPPAN RIVER LOWLAND (part of the Spatsizi and Klastine Plateau)

The broad floors of Stikine and Klappan River valleys are mantled by deep drift, including till, glaciolacustrine sediments (chiefly silt) and glaciofluvial gravels. Postglacial downcutting into the drift by the rivers and their major tributaries has resulted in the formation of small inner valleys. These are bounded by steep slopes where many postglacial landslides have occurred - and are still occurring - in glaciolacustrine sediments and till, and floored by postglacial river terraces and modern floodplains. Away from the inner valleys, relief is commonly low, especially between Stikine River and Spatsizi Plateau. Extensive areas of glaciofluvial gravels, including eskers, kames, kettles and kame terraces, and numerous meltwater channels suggest that stagnant ice occupied these valleys during deglaciation.

3. SURFICIAL MATERIALS AND LANDFORMS: THEIR LAND CAPABILITY, ASSOCIATED HAZARDS, AND RESOURCES

Surficial materials are those sediments of relatively young geological age that underlie much of the land surface, such as sand, gravel, and glacial till. These materials overlie bedrock and constitute the parent material for most soil. (In this report, "soil" is used in the pedological and agricultural sense to refer to the medium that is capable of supporting plant growth. "Surficial material" is equivalent to soil in an engineering sense).

The physical characteristics of any surficial material are largely a function of its original mode of deposition. Basal till, the highly compacted and cohesive mixture of particles of all shapes and sizes that accumulates beneath a glacier, is obviously quite different from fluvial (river) deposits which consist of loose sand and rounded gravel particles that have been sorted by flowing water into layers of uniform particle size. Thus the genetic basis of surficial material nomenclature (fluvial, lacustrine, volcanic, etc.) is a direct indication of surficial material characteristics. Characteristics such as particle size and degree of compactness control the properties and behaviour of surficial materials such as porosity, permeability, compactibility, bearing strength, and susceptibility to erosion and slope failure.

A standard format is used in order to facilitate the following descriptions. Information about land capability, hazards, and resources is summarized in Table 1 (see Section 3.12).

3.1 TILL, MORAINE Map Symbol "M"

Origin: Deposited by glaciers: basal till (mapped as M with texture omitted) was deposited beneath ice; ablation till (gM, sgM) accumulated

upon a glacier surface as it was lowered by melting; till ridges (moraines, xMr) formed recently around the margins of glaciers and ice sheets.

Note: The term "till" normally refers to the material and "moraine" to landforms that consist of till.

Distribution: Basal till is widespread on valley floors and lowlands where it is thickest, and on gently and moderately sloping valleysides. Ablation till was mapped in only one area - lower Yehiniko Creek - but it may commonly overlie basal till. Recently deposited till (xM) in morainal ridges and other landforms is exposed near present glacier terminii.

General appearance in exposures: Rock fragments (coarse fragments) of various shapes, sizes, and rock types are set in a matrix of intermixed sand, silt and clay; stratification is normally not visible, particularly in small exposures, although joints (cracks) may have formed due to drying and shrinking of the material; colour when moist is normally dark grey or dark brown. (See description of tills in Appendix B.)

Texture: The results of field observations and laboratory analyses of till texture are given in Appendix B. The matrix of basal till is most commonly either sandy mud (mud is defined as a mixture of silt and clay), or silty sand, or sandy silt. The coarse fragment content of till is variable, even at a single site: values of 20 to 50% (by volume) are most typical, although observations range from 15 to 85%.

Comparison of till texutures with bedrock geology (Souther, Brew and Okulitch, 1979) shows no clear relationship between matrix texture and bedrock type, such as is normally expected. Whilst it is certain that glacial transport of debris modified this pattern to some extent, it is also likely that such sampling as is possible during a 1:250 000 scale mapping project is (and was) inadequate for identification of this relationship. Conse-

quently a few suggestions, based upon the writer's general experience, about likely variations of till texture in accordance with bedrock geology, are in order.

The generalized geology map (Figure 3) shows the broad distribution of rock types that may correspond approximately with tills of particular texture.

Plutonic rocks (coarse textured igneous rocks) generally give rise to a relatively coarse till matrix in which sand is the major component; proportions of silt and grit (2 - 8mm) may also be relatively high. Such tills also contain many boulders and cobbles. Sandy tills (silty sand matrix) derived from plutonic rocks occur at sites TC 30, TC 67, IS 9 and IS 10.

Volcanic rocks normally produce a relatively fine textured (silt, or sandy silt) till matrix. This is partially a reflection of the fine texture of the parent rock (lavas) and partially a result of weathering. However, where rock age is comparatively young, and where pyroclastic material has been incorporated, as in the vicinity of Edziza, textures may be quite variable.

Sedimentary rocks incorporated into till tend to disintegrate into their original constituents. Thus stony tills may be expected from conglomerates, sandy tills from sandstones and greywackes, and silt to clay tills from siltstone and shale. Sedimentary rocks of various textures are commonly interbedded, however, as in the Skeena Mountains and adjacent Iskut River valley, and a more heterogeneous till results. In fact, the common sandy mud and sandy silt till may well derive from these rocks and other similarly mixed formations. Tills derived from limestone tend to be fine textured with silt to silt-clay (a mixture of silt and clay) matrix.

Metamorphic rocks give rise to tills that range from silt-clay texture (phyllite, argillite, some schists) to silt (some schists, some quartzites) and silty sand (gneiss).

Till may consist of reworked older drift. Where this is the case, its texture reflects that of the original sediments. Fraser Glaciation till along parts of Stikine River valley near Telegraph Creek and in map area 104H rests upon glaciolacustrine and glaciofluvial sediments: tills sampled at sites TC 32 and TC 34 - sandy silt and gravelly sand respectively - appear to be largely derived from these. Other areas of thick drift where similar relationships may hold are indicated by stratigraphic information on the terrain materials map, e.g. $\frac{\text{"Mmw/Gtf"}}{\text{Rmj.L}}$ near Refuge Lake.

Ablation till is a non-sorted mixture of gravel and sand, possibly with minor silt and clasts of basal till.

Till in recent moraines tends to contain a higher proportion of angular rock fragments and a lower proportion of matrix than typical basal till. Hence it is mapped as "xM". (See examples listed in Appendix B, Table B.1.)

Compactness and Cohesion: Basal till is normally the most highly compacted and most cohesive of all surficial materials; ablation till is non- or slightly compacted; compaction of recent till is variable and dependent upon local conditions.

Hydrology: The weathered surface layer, 1 to 2 metres thick, of basal till is permeable. Unweathered till is slightly permeable to impervious, with permeability decreasing with increasing compaction and finer texture. The upper surface of unweathered till thus restricts soil water movement, and water tends to flow downslope through the lower part of the unweathered material (Figure 4).

The effectively impervious nature of basal till gives rise to surface or near surface runoff which promotes surface erosion and gullying. It also results in poor drainage and high groundwater tables in depressions, slope concavities, and at sites near the foot of slopes.

FIGURE 4. SHALLOW GROUNDWATER MOVEMENT IN TILL

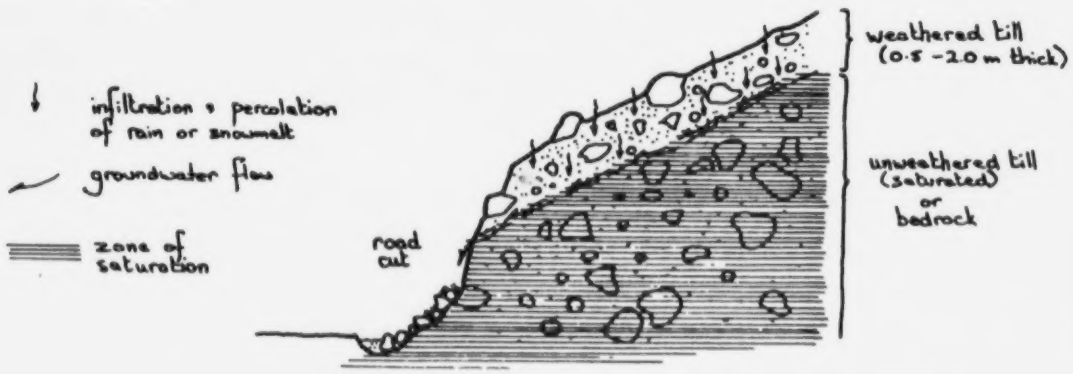
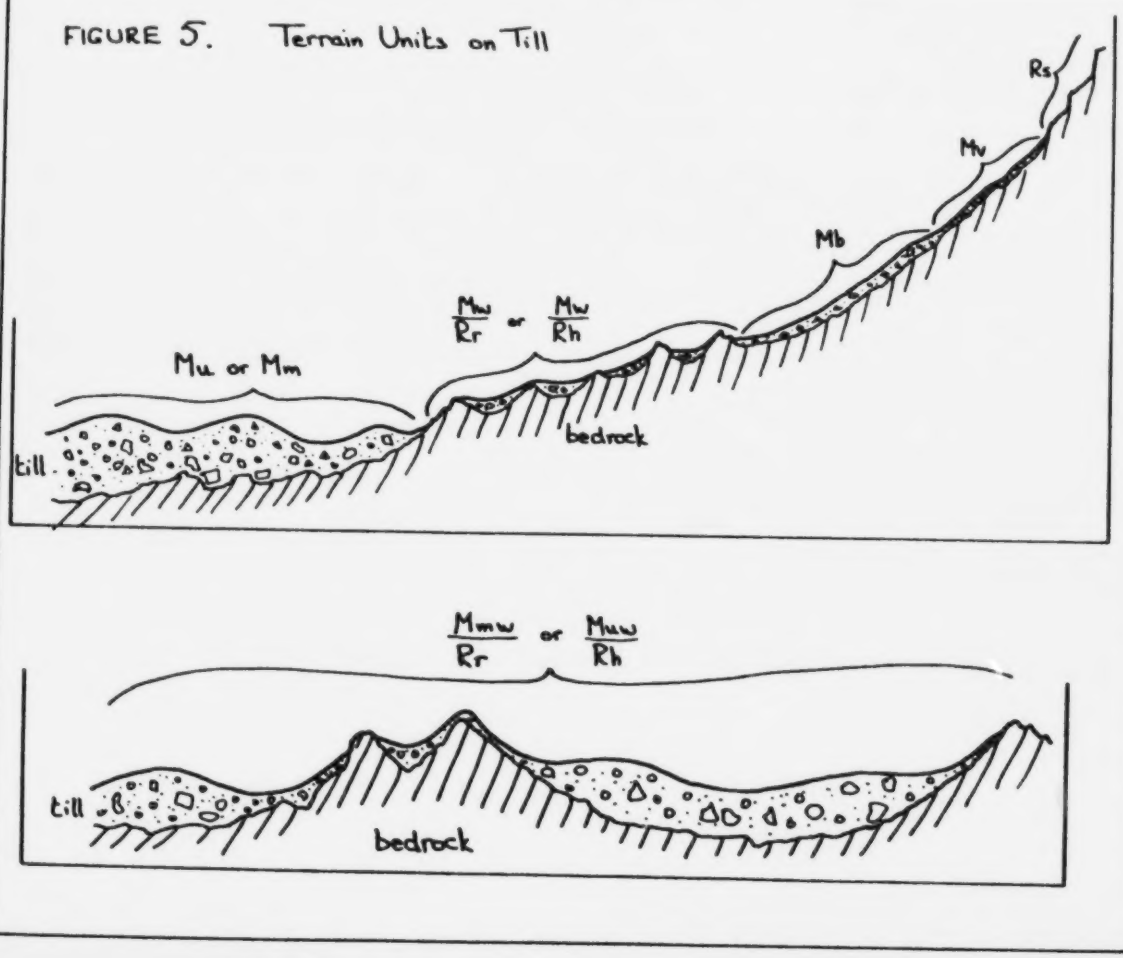

infiltration + percolation of rain or snowmelt
groundwater flow
zone of saturation
road cut
weathered till (0.5 - 2.0 m thick)
unweathered till (saturated) or bedrock

FIGURE 5. Terrain Units on Till



Comment On Land Capability: Some properties of basal till vary with its texture and mineralogical composition, including plasticity, strength, stability on slopes, and frost-heave potential. Hence the ratings given for basal till in Table 1 should be considered as only a very general guide to land capability.

Common Landforms and Terrain Units:

Terrain units on till are illustrated in Figure 5.

Mv - Till veneer: till of relatively uniform thickness and generally less than 1 to 2 m thick. It most commonly overlies bedrock and is interupted by bedrock outcrops.

Mb - Till blanket: thicker till of relatively uniform thickness and characterized by smooth slopes.

Note: Normally the surface topography of Mv and Mb terrain units is shown by the underlying bedrock, eg. $\frac{\text{"Mb"}}{Ru}$ (undulating topography). If bedrock information is omitted, then slopes are long and uniform and their gradient is indicated by contour spacings on the topographic base map.

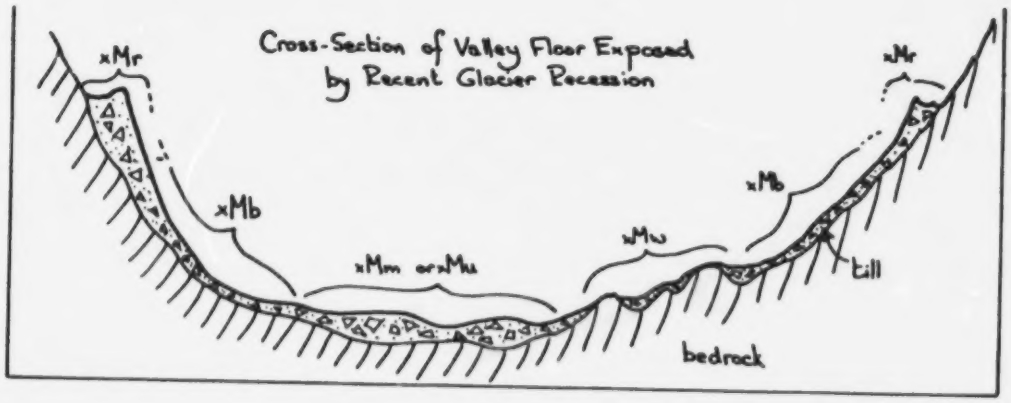
Mw - Till mantle of variable thickness: thicker in depressions and thinner or absent on ridges and knolls.

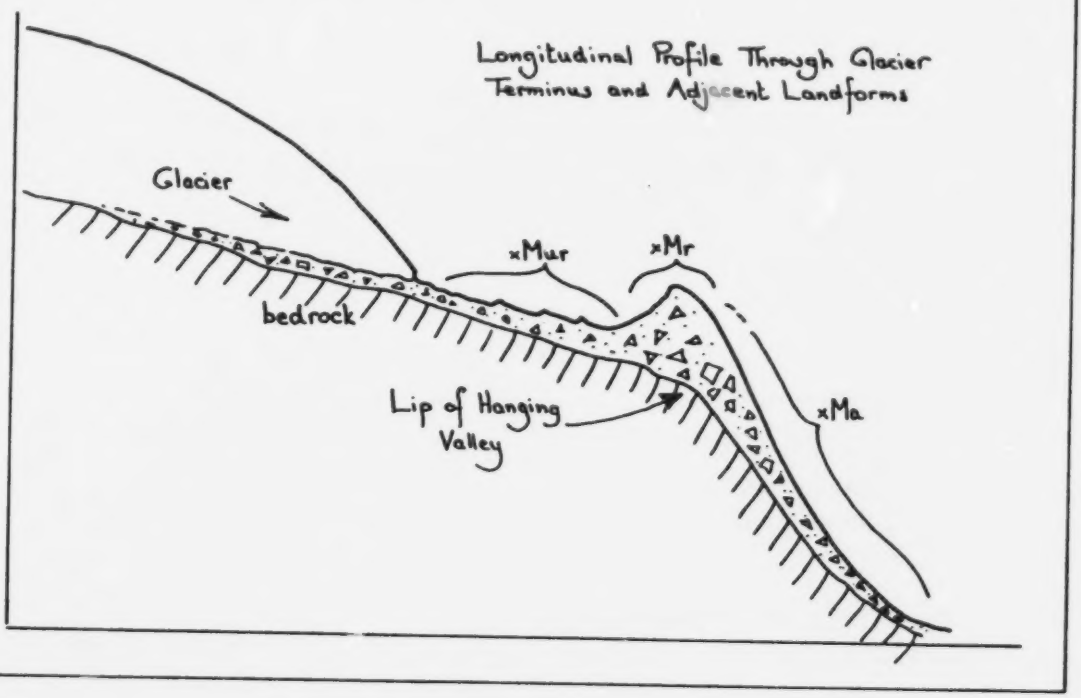
Mu - Undulating till: ground moraine; relatively thick till.

Mm - Rolling till: drumlinoid topography; relatively thick till.

xM - Recent moraines and other landforms: see Figure 6.

FIGURE 6. TERRAIN UNITS ON RECENT MORAINES (xM)





3.2 FLUVIAL SEDIMENTS AND LANDFORMS Map Symbol "F"

Origin: Deposited by streams and rivers (flowing water in channels).

Distribution: Along and close to present channels. The greatest accumulations of fluvial sediments lie beneath the modern floodplains and fans of rivers and streams in the Coast Mountains such as the Scud, Stikine, Iskut and Chutine. Many smaller streams are bordered by fluvial sediments that occupy areas too small to show on the 1:250 000 map.

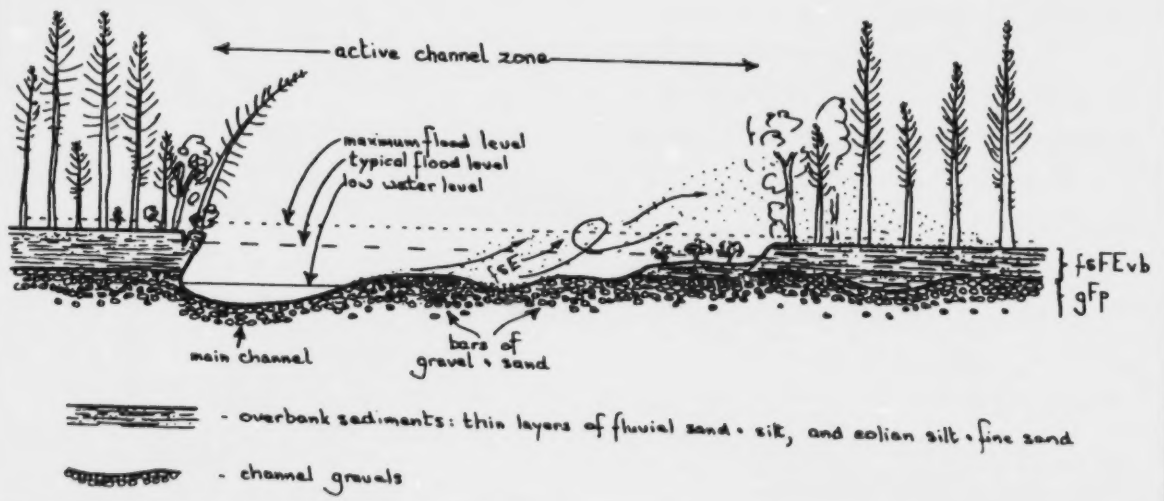
General appearance in exposures: Sands and gravels: gravel particles are usually rounded or subrounded; they vary in size from pebbles to boulders, but are normally arranged in layers of roughly similar size; stratification or bedding is usually present but not always obvious, and it may be horizontal or dipping (cross-bedding).

Texture: Steep alluvial fans consist of non-sorted and non-stratified bouldery gravel (i.e. boulders mixed with smaller clasts and sand). Typical fluvial gravels, such as those which cap terraces along Stikine River, consist of well sorted pebble and cobble gravels. Floodplains along low gradient rivers are mantled by moderately to well sorted silt and sand (Figure 7).

Compactness and Cohesion: Gravels and sands are loose and non-compacted; silts are slightly cohesive and non-compacted.

Hydrology: Sands and especially gravels are highly permeable and permit rapid infiltration of surface water and rapid groundwater flow. Floodplains and "active" fans are commonly poorly drained due to high groundwater tables, but terraces and relict high-level fans are relatively dry.

FIGURE 7. CROSS-SECTION OF FLOODPLAIN
TERRAIN UNIT: $\frac{fsFEvb}{gFp}$ - JB



- overbank sediments: thin layers of fluvial sand + silt, and eolian silt + fine sand

- channel gravels

Comment on Land Capability and Resources: River terraces and relict alluvial fans normally provide excellent sites for settlements and other construction, and good sources of aggregate and fill. They also constitute potential agricultural land where climate is suitable.

Comment on Hazards: See Section 4.1 for discussion of hazards on fans and floodplains.

Common Landforms and Terrain Units:

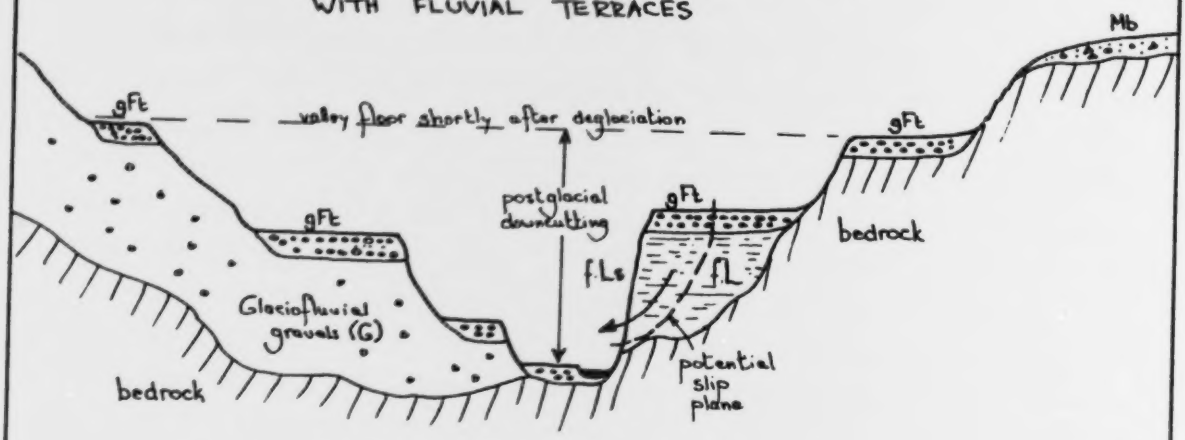
Ff
Ff - B
gFf
etc.

- Alluvial fans: fan-shaped bodies of relatively coarse fluvial sediments deposited where creeks emerge from narrow, steep valleys onto plains or lowlands. Most fans are mapped in combination with adjacent plains, eg. "gFpf - B". Some fans are shown only as gravel sources, on-site symbol (g). Many small and isolated fans are unmapped.

Ft
gFt
sEv/gFt
etc.

- Fluvial terraces, river terraces: a terrace capping of fluvial gravel normally overlies either older surficial materials or bedrock. At some locations where this capping is thin, the physical character of the terrace surface - especially drainage - may be influenced by the underlying material. Along parts of Stikine, Iskut and Klappan Rivers, and parts of Mess and Schaft Creeks, fluvial terraces are underlain by glaciolacustrine sediments and terrace edges may be subject to landslides, (see terrain materials map for locations and Figures 8 and 10).

FIGURE 8: CROSS-SECTION OF TYPICAL VALLEY WITH FLUVIAL TERRACES



Note how fluvial terraces consist of cappings of fluvial gravel that overlie older surficial materials or bedrock. Fluvial terraces underlain by glaciolacustrine silt or clay are potentially unstable.

Fp
Fp - B
$\frac{sFv}{gFp}$ -I
$\frac{sEv}{gFpf}$ -B
$\frac{fsFEvb}{gFp}$ - JB
etc.

- Floodplains and active channel zones: various combinations of texture may be shown. Fluvial processes indicated by channel patterns (-B, -I, -J, -M) are described in Section 4.1. Relatively complicated terrain unit symbols (lower three examples) have been used to describe floodplains where a discontinuous veneer of silt and/or sand overlies gravels (Figure 7). In these cases, the underlying gravels, "channel gravels", were deposited along the river channel as it shifted sideways across its floodplain over long periods of time. The overlying finer sediments are of fluvial (most commonly) or eolian origin; (see next paragraph). "Overbank sediments", were deposited by settling of the river's suspended load when the floodplain was inundated by standing or slow-flowing water. Each flood left a thin layer of silt or fine sand, a fraction of a millimetre to several centimetres in thickness. Overbank sediments may build up to a thickness of 1 or 2 metres, hence they are shown as Fv or Fb. Their distribution corresponds approximately to that of mature forest on the floodplain.

$\frac{fsFEvb}{gFp}$ - JB and similar terrain units along lower Stikine River: strong wind action in this area removes silt and sand from unvegetated channels and bars and redistributes it on areas that are protected by vegetation. Thus overbank and eolian sediments are interlayered.

3.3 GLACIOFLUVIAL SEDIMENTS AND LANDFORMS Map Symbol "G"

Origin: Deposited during Fraser Glaciation by meltwater streams either in contact with a glacier or some distance beyond the ice terminus.

Note: The usual definition has been restricted to the last major glaciation in order to simplify terrain mapping and map interpretation in

the Stikine - Iskut area. Modern glacial outwash plains - the entire floodplain of Scud River for example - are mapped as "F". Thus interpretation of flood hazard areas is limited to one ("F") type of terrain, and the problem of defining the downstream limit of modern outwash is eliminated.

Distribution: Small and scattered areas: most notable are Morchuea Lake lowland (ice-disintegration features, eskers, kames), lower Burrage Creek (large delta), lower Grand Canyon of the Stikine (terraces and kames); Tsenaglode Mountain, an area east of Cullivan Creek, and east of Stikine River have terraces, kames, ice disintegration features, and eskers. (See also eskers, meltwater channels, and glaciofluvial deltas on terrain features map.)

General Appearance In Exposures: Gravel and sand of variable character, but generally less rounded, less sorted, and less regularly stratified or bedded than fluvial materials. Bedding in ice-contact gravels may have been warped and distorted by faulting and slumping. Glaciofluvial materials may contain boulders, lenses and boulders of till, and pockets of glaciolacustrine sediments.

Texture: Variable; most commonly gravel and sand, but ranges from silt to boulders.

Compactness and Cohesion: Gravels and sands are non-compacted and loose.

Hydrology: See fluvial sediments for sand and gravel properties. Sites on glaciofluvial gravels are generally dry and well drained: crests of ridges and hummocks constitute the driest sites in an area. Glaciofluvial sediments may contain groundwater at depth, and they may function as aquifers where they are sandwiched between less permeable strata.

Common Landforms and Terrain Units:

Gp - Outwash plains

Gf - Glaciofluvial fans

Gt - Kame terraces, terraces high above present river levels, and deltas constructed into glacial lakes.

Gr - Gravel ridges, probably eskers or crevasse fillings.

Gh, Gu - Hummocky or undulating terrain on glaciofluvial gravels and sand; kames; may include areas of till.

Gw, Gb - A surface cover of glaciofluvial gravel or sand with no particular landform; (see underlying material for surface expression).

3.4 GLACIOLACUSTRINE SEDIMENTS Map Symbol "L"

Origin: Deposited in glacial lakes by settling of suspended sediment from meltwater streams.

Distribution: Mapped only as a component of complex terrain units in Stikine River valley near Telegraph Creek and in mapsheet 104H, Mess Creek valley, Morchuea Lake lowland, Iskut River valley, lower Ball Creek and Klappan River valley. The extent of glaciolacustrine sediments within these terrain units is not known, since this material was observed chiefly as a stratigraphic unit in riverbank sections where it is overlain by other drift or fluvial gravels. Small bodies of glaciolacustrine sediment may be present in other parts of the map area: it is probably the least reliably mapped of all surficial materials in this area.

General appearance in exposures: Pale grey or buff, stratified or non-stratified, fine textured sediment; may contain occasional ice-rafted stones; vertical joints (cracks) are commonly present.

Texture: Most typically silt and silt interbedded with fine sand and/or clay, except in Iskut River valley near Eastman Creek where clay predominates. (See Appendix B, Table B.2 for examples.)

Compactness and Cohesion: Sediments that lie beneath till may be moderately to highly compacted, dependent upon local conditions at time of glacial overriding. Sediments that post-date Fraser Glaciation are only slightly compacted and may have very low bulk density; they may subside when loaded. Particle to particle cohesion is relatively high in silts and clays, but the material as a whole disintegrates readily along near-surface cracks and fissures which develop due to drying and shrinking.

Hydrology: Permeability of silts and clays is relatively low, but water may move laterally along interlayered sand beds. Flat areas and depressions are poorly drained.

Comment on Hazards and Land Capability: Glaciolacustrine sediments are commonly involved in landslides and slumps, even where they are overlain by younger sediments (see Section 4.5.1). They are also subject to surface (gullying) and subsurface (piping) erosion.

Common Landforms and Terrain Units:

Lb - Blanket of glaciolacustrine sediments: sediments of relatively uniform thickess with surface expression that copies that of the underlying unit.
Lt - Terrace of glaciolacustrine sediments.
L - Stratigraphic unit with surface expression unknown.

3.5 COLLUVIAL SEDIMENTS AND LANDFORMS Map Symbol "C"

Origin: Deposited as a result of downslope movement of rock and debris due to gravity; includes slopewash deposits. For mapping purposes, physic-

ally weathered rock fragments (disintegrated bedrock) on level or gently sloping surfaces that have undergone little, if any, downslope movement are also classed as colluvium.

Distribution: Widespread. Weathered rock debris covers large parts of most plateaux. Colluvium is present on and at the foot of moderate to steep slopes. Conventions written into the terrain materials map legend in order to simplify terrain unit symbols (see definitions of till and bedrock) result in an underestimation of the extent of colluvium on the map.

General appearance in exposures: Angular fragments of local rock with interstitial sand and silt; stratified or non-stratified. Debris flow deposits are well bedded; they may contain erratics, and may resemble till in appearance.

Texture: In general the texture of colluvium depends, like that of till, upon the type of bedrock or surficial material from which it was derived. Rock texture influences the size of interstitial material (see descriptions under till texture, Section 3.1), whilst the spacing of planes of weakness in the parent rock (joints, bedding planes) determines the size of coarse fragments. Plutonic rocks, gneiss and some quartzites tend to be coarsely jointed and release large blocks, commonly one metre or more across in rockfall debris. At the other extreme, shale, siltstone and phyllite break down into tiny fragments. Clastic sedimentary rocks in general disintegrate into their constituent particles. For example, parts of the upland surfaces in the Skeena Mountains and Spatsizi Plateau are covered by sandy gravel (i.e. rounded pebbles) as a result of weathering of conglomerate. Readers are referred to the generalized geology map for an overview of colluvium texture. Some examples are listed in Appendix B, Table B.2.

Compactness and Cohesion: Most colluvial material is non-compacted and loose. It may contain large voids (empty spaces). Debris flow deposits that contain a high proportion of silt-clay matrix (chiefly those that consist of reworked till) are slightly to moderately compacted and moderately cohesive.

Hydrology: Most colluvial materials are highly permeable and permit rapid infiltration. Since they commonly occupy sloping ground, they tend to be rapidly drained and dry, with the exception of landslide deposits which normally contain seepage zones, swampy depressions, and small lakes. Where colluvium overlies bedrock, groundwater may move downslope through its lower layers and give rise to poorly drained areas or surface seepage near the foot of the slope.

Comment on Hazards and Land Capability: When interpreting the 1:250 000 scale terrain materials and terrain hazards maps, it is advisable to assume that the presence of colluvial materials on or at the foot of a slope is an indication that material may still descend that slope from time to time, and hence a potential hazard exists. Snow avalanches are also common on colluvial slopes. Further discussion of slope processes is given in Sections 4.3 to 4.6 of this report.

Common Landforms and Terrain Units:

Ca - Talus slopes
Cc - Talus cones } deposited primarily by rockfall.

Cf - Colluvial fans: less steep than talus slopes; deposited primarily by debris flows.

Cv - Most commonly describes a thin cover of colluvium on slopes, but also used for veneers of disintegrated bedrock on plateaux.

Cb - Blanket of colluvium.

Cw - Most commonly describes disintegrated bedrock of variable thickness on plateaux; also used to describe pockets of colluvium on irregular slopes.

Note: On the terrain materials map, colluvium on slopes ("Cv, Cb, Ca, or Cw")can usually be distinguished from disintegrated bedrock on plateau (e.g. $\frac{\text{"Cw"}}{Ru}$) by the presence of bedrock information in the latter symbol, as well as by recognition of topography from contour lines.

Cr, Cm - Used to describe rock glaciers (see 5.0).

xCh, xCr - Debris of major rockslides (landslides in bedrock), see 4.5.2 and and 4.5.3.

3.6 EOLIAN SEDIMENTS AND LANDFORMS Map Symbol "E"

Origin: Deposited by wind; derived chiefly from the active channel zones of floodplains, but also from rock weathering and volcanic eruptions.

Distribution: Eolian sediments up to about one metre in thickness cap fluvial terraces, "inactive" parts of floodplains, and other adjacent surfaces. A capping of eolian sediment a few centimetres in thickness is widespread on plateaux and other gently sloping areas at all elevations. However, since it is not possible to map the distribution of eolian veneers by air photo interpretation, they are shown on the terrain map only where their presence was confirmed by ground observation.

General Appearance In Exposures: Thin layer of non-stratified fine sediment of uniform texture.

Texture: Fine sand and silt.

Compactness and Cohesion: Non-compacted and non-cohesive, but may be weakly cemented by calcium carbonate in drier areas.

Hydrology: Permits moderate to high rates of infiltration.

Common Landforms and Terrain Units:

Ev - Eolian veneer

Note: Dunes shown on the terrain features map near Mess Lake probably consist of tephra (volcanic ash); they were not examined on the ground. Dunes near the head of Taweh Creek consist of pumiceous sand and overlie a postglacial lava flow.

3.7 ORGANIC SEDIMENTS Map Symbol "O"

Origin: Formed by decay and accumulation of vegetative matter.

Distribution: Widespread in depressions and on poorly drained level surfaces; are more common than shown on terrain map; may contain ground ice (see Section 4.2.6).

General Appearance In Exposures: Dark brown or black organic matter in which fragments of vegetation, ranging from plant fibres to tree stumps, can generally be distinguished.

Compactness and Cohesion: Non-compacted and non-cohesive; subsides when drained and when loaded without prior drainage.

Hydrology: Very poorly drained; may be seasonally inundated.

Common Landforms and Terrain Units:

Ob - Blanket of organic material
Ov - A thin cover of organic materials; commonly over basal till.

3.8 VOLCANIC MATERIALS AND LANDFORMS Map Symbol "V"

Origin: Lava and pyroclastic material (cinders, ash) erupted since Fraser Glaciation.

Distribution: Widespread on Edziza plateau and extending into Klastline River valley; small areas in Spectrum Range, Klastline Plateau, Iskut River valley and several of its tributaries. (Older volcanic materials are mapped as bedrock.)

General Appearance and Texture: Lava flows (xV) have rough, irregular surfaces that consist of loose, jumbled blocks of scoria (pumice-like black lava). The most recent flows bear little vegetation but older flows at low elevations are forested. Pyroclastic material ranges in texture from boulder-sized volcanic bombs, through cinders (gV), to tephra (volcanic ash) of sand and silt-sized particles (sV, fV). Tephra ranges in colour from black to pale buff, dependent upon its mineralogical composition.

Compactness and Cohesion: Pyroclastic materials are non-compacted. They are loose where observed at the gound surface, but probably indurated (welded together) at depth. Lava flow material becomes denser (i.e. less cavities) with increasing depth below the ground surface.

Hydrology: Pyroclastic materials are highly porous and permeable. They constitute well drained and dry terrain with few surface streams. Lava flows also appear to be well drained, possibly because water can readily pass downward through the typically well developed system of columnar joints.

Common Landforms and Terrain Units:

xVb, xVr, xV... – Lava flows

gV – Cinders, volcanic bombs

sVv, fVv – Veneers of tephra (volcanic ash) deposited directly by air-fall during eruptions, and later partially reworked by wind and steams.

gVh – Cinder cones, but see symbol on features map for more complete distribution of this feature.

3.9 BEDROCK Map Symbol "R"

Definition: Consolidated rock

Distribution: Widespread: bedrock is mapped where it outcrops and where it is covered by only a few centimetres of surficial material.

Characteristics: Whilst most physical properties of bedrock are quite different from those of surficial materials, there is also considerable variation between one type of bedrock and another. Characteristics that relate to land use and resources, such as strength, drainage, susceptibility to slope failure, hydrology, rippability, and suitability of crushed rock for aggregate and fill, depend upon the mineralogy (which influences hardness and weathering rates), texture, and structure (spacing of joints and bedding planes, direction and angle of dip) of bedrock. Description of the physical characteristics of bedrock is beyond the scope of this report; see Bell (1981) for some general information.

Common Landforms and Terrain Units:

Rs – Steep slopes on bedrock (and colluvium)

Rh – Hummocky bedrock (and minor colluvium)

Rsh - Adjacent areas of steep and hummocky bedrock.
Rr - Ridges of bedrock
Rrh - Intermixed hummocks and ridges of bedrock
Ru - Undulating topography on bedrock
Rm - Rolling topography on bedrock
Rj - Long, gentle slopes on bedrock

3.10 ICE Map Symbol "I"

Definition: Permanent snow and ice; glaciers and snowfields.

Note*: Glacier snout positions and the general extent of ice on the terrain map were drawn from 1974 air photos. The topographic base map was compiled from 1949 air photos. One might expect, then, that differences between the position of ice margins on the terrain and base maps indicate the amount of glacier recession that has occurred over the 25 year time interval. Unfortunately this is not the case. Close comparison of the base map with 1974 air photos indicates that the base map ice margins are, in some places, drawn along the outer edges of fresh (i.e. light coloured) morainal areas. These moraines indicate the maximum extent that glaciers achieved during the "Little Ice Age" of the eighteenth and nineteenth centuries, and certainly predate 1949.

3.11 COMPLEX TERRAIN UNITS (not covered by the above descriptions)

Terrain Unit Symbol: $\frac{\text{Ft.Gth}}{\text{M.G}}$ .Vts.Us
Rt.L

Location: Lower part of "Grand Canyon of the Stikine": Stikine River valley upstream from Telegraph Creek.

*Refers to mapsheet 104G.

Description: Terrain and stratigraphic units are illustrated schematically in Figure 9. These cross-sections were compiled from observations of river bank exposures and road cuts made from the road between Telegraph Creek and the bridge across Tahltan River. No detailed inspections of sections were carried out.

Terrain Unit Symbol: $\text{fgdUas}/\frac{\text{Fptf}}{\text{U}}$ - FVI

Location: Mess Creek valley

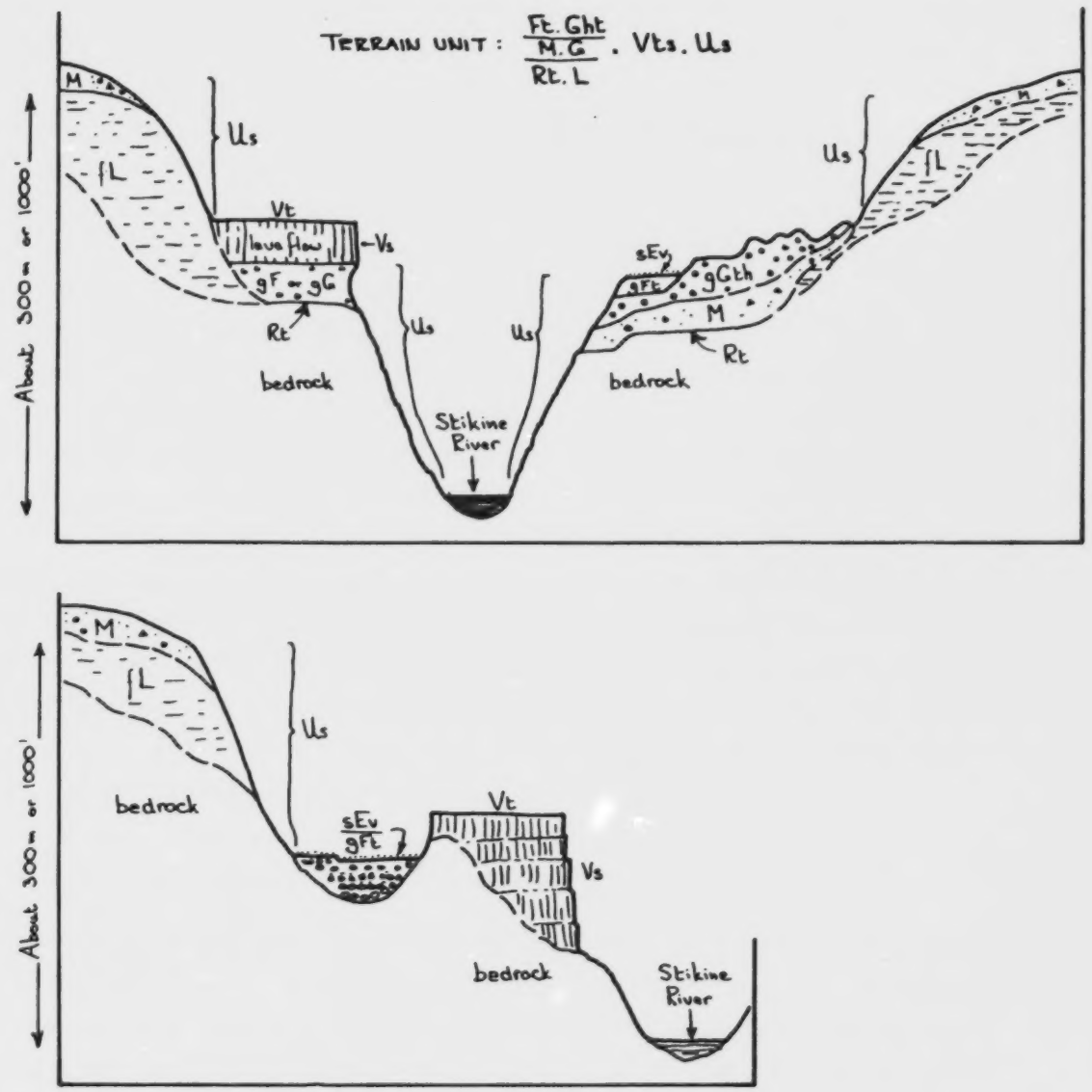
Description: Undifferentiated sediments include glaciolacustrine silts, till (with "d" - diamicton texture), and glaciofluvial gravels. These materials were observed in several sections along the scarp slopes adjacent to Mess Creek, but no clear order of superposition could be determined. Slumps and sides (-F) and gullying (-V) are proceeding on these scarps. The present floodplain of Mess Creek and adjacent terraces (Fpt) have cut into the undifferentiated sediments, and alluvial fans (Ff) have been constructd upon floodplain and terrace surfaces. Mess Creek channel pattern is irregularly meandering.

Terrain Unit Symbol: $\frac{\text{Grtb.Fpft}}{\text{M.L}}$/Us - VI

Location: Mess Creek valley

Description: Close to river level the valley floor consists of a narrow floodplain (Fp - I) with fans (Ff) from tributary creeks (including Schaft Creek) and adjacent low terraces (Ft.). Higher benches are composite features and include ridges (kames or eskers) (Gr), terraces (Gt), and a general covering (Gb) of glaciofluvial gravel. Gravels appear to overlie glaciolacustrine silts and sands and till in several exposures along the scarp slopes that separate the lower fluvial ter-

FIGURE 9. SCHEMATIC CROSS-SECTIONS OF STIKINE RIVER VALLEY NEAR TELEGRAPH CREEK.



rain from the higher glaciofluvial terrain. In a large exposure on Schaft Creek near its confluence with Mess Creek, a lava flow is interbedded with deltaic gravels. The stratigraphic relationship of "M" and "L" units was not clearly discerned, hence they are written side by side. Scarp slopes which consist variously of "F", "G", "L", "M", and "R" materials are mapped as "U". They are undergoing gullying, "-V".

Terrain Unit Symbol: $\frac{xVb}{Fp.Ra}$.Us.Fpf.Rts

Location: Valley of Klastline River

Description: The first component describes recent lava flows (xVb) from northern Edziza plateau that have flowed into this valley and buried bedrock slopes (Ra) and part of the floodplain (Fp). The second component describes scarp slopes that bound the valley floor, particularly along its northern side, and are underlain by unconsolidated materials (Us). Clear exposures of these were not found, but small cuts and land surface characteristics suggest that they probably consist of till overlying (glacio)fluvial and (glacio)lacustrine sediments. These date from valley blockage either by ice or by lava flows. The third componet (Fpf) is the modern floodplain of Klastline River and fans from tributary creeks. The fourth component is older lava flows at elevations higher than the modern floodplain. These now constitute terraces and scarp slopes (Rts) where they have been partially eroded.

Terrain Unit Symbol: $\frac{sFv}{gFp}$/Us.Rs - I

Location: Valley of Klastline River

Description: The first component is relatively more extensive than the other two. It describes a floodplain that consists of overbank sands

resting upon channel gravels and an irregularly meandering river ($\frac{sFv}{gFp}$ -I). The second component, Us, represents (glacio)fluvial gravels with an interlayed lava flow, till, and underlying (glacio) lacustrine silts and sands that outcrop along the scarp slope that marks the edge of the valley floor. Parts of this same scarp are outcrops of columnar lava (Rs) and talus slopes.

Terrain Unit Symbol: $\frac{Mmw/Gtf}{Rmj.L}$

Location: Iskut River valley near Eastman Creek

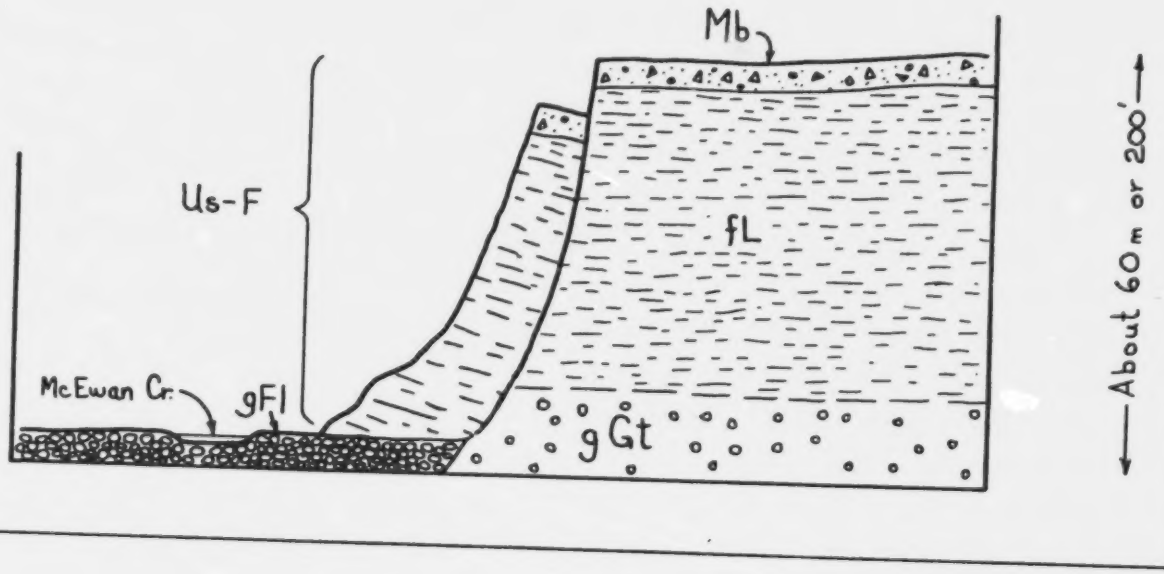
Description: Beneath slightly higher ground, till of variable thickness (Mmw) overlies bedrock (Rmj). At lower elevations and closer to Iskut River, till and glaciofluvial sediments are thought to overlie glaciolacustrine sediments. Materials of the latter type were not actually observed here, but their presence is inferred on grounds of contiguity with adjacent areas.

Terrain Unit Symbol: $\frac{Mb}{sL}; \frac{Mb}{Lt}; \frac{Mu}{fL}; \frac{}{Gtf}$ Us-F

Location: Stikine - Klappan Lowland

Description: Along the valleys of Stikine and Klappan Rivers till (Mb, Mu) commonly overlies older glaciolacustrine sediments (sL, fL, Lt) which in turn overlie glaciofluvial gravels (Gtf). Stratigraphic sequences such as shown here, and more complex sequences, are commonly exposed along the steep, unstable slopes of the inner valleys (Section 2.16). These slopes are commonly mapped as Us-F_s. An example is shown in Figure 10.

FIGURE 10. SCHEMATIC CROSS-SECTION OF McEWAN CREEK NEAR ITS CONFLUENCE WITH THE KLAPPAN RIVER



Terrain Unit Symbol: gxVsr/xCcvb; $\frac{feVvb}{Vrh}$

Location: Hoodoo Mountain

Description: The symbol gxVsr represents a complex sequence of recent volcanic strata, including both vesicular and dense lavas (xV), cinders and volcanic bombs (gV), and tephra. The terrain is highly disected and affected by gully erosion, rapid mass wasting, and avalanches.

The lower slopes of Hoodoo Mountain consist of lava flows (Vrh) overlain by fine textured volcanic ash (fEVvb).

3.12 LAND CAPABILITY AND RESOURCES

Table 1 is intended as a general guide to the physical capability of various types of terrain for certain land uses. Map users should realize that the given ratings: D (desirable), P (possible problems), and U (unsuitable), are based upon only the typical properties of materials and take into account neither the many other factors (eg. topography, climate) which influence the suitability of an area for a particular land use, nor those that create variability of land surface conditions even within an area of uniform surficial material. For example, talus material may provide a firm foundation for a low rise dwelling (rating is "D"), but the steep gradient of the talus slope (a constraint) and the possibility of rockfall (a hazard) precludes the possibility of settlement on such a site. As a second example, consider an undulating area underlain by basal till: a material that normally offers good conditions for foundations. However, under moderately humid conditions (eg. almost anywhere in the Stikine - Iskut area) low lying areas, depressions, and concavities on till are wet and poorly drained (a constraint), whereas adjacent knolls offer suitable building sites.

Within the context, "hazards" (geological hazards) are defined as naturally occurring geological processes that constitute a risk to human

life and property. They include phenomena such as snow avalanches, debris flows, landslides, floods, and shifting river channels. Although the danger posed by geological hazards can in some cases be averted by special engineering works, this solution should only be applied where considerable development has already taken place, unwittingly, within a hazardous zone. When new development or construction is planned, sites threatened by natural processes should be avoided. Hazards due to earthquakes and volcanic eruptions are not considered here.

"Constraints" are natural conditions that pose problems for development such as steep slopes or high watertable. They can normally be overcome by artifical site modification such as excavation or drainage, but since this is likely to increase development costs, sites that are free from constraints should be selected where possible.

Constraints and hazards that are typically associated with particular types of surficial material and landforms are listed in columns 10 and 11 of Table 1. Additional geological processes that constitute hazards are shown on the terrain hazards maps, and are described in Section 4 of this report.

When Table 1 is used together with the terrain materials and terrain features maps, it provides a general guide to land capability and resources in the Stikine - Iskut area. (It should not be applied to other map areas.) Users should bear in mind the nature of the reconnaissance survey upon which this information is based (Section 1.3). The table and maps can be used, for example, to identify two or three alternative corridors for location of a road (but not the precise route), or several possible locations for a townsite. More detailed mapping (1:50 000 or larger scale) would be necessary for selection of a particular corridor or site, and then more detailed mapping again and site specific engineering investigations before precise plans of road location or townsite layout are finalized.

Table 1

Summary of Land Capability, Constraints, Hazards and Resources for Common Terrain Units

Material and/or Landform	Terrain Unit Symbol	LAND CAPABILITY								Constraints most likely to be encountered	Hazards most likely to be encountered	RESOURCES		
		Light foundations (low rise dwellings)	Heavy foundations	Ease of excavation	Liquid waste disposal	Solid waste disposal	Highways, airfields and roads	Unpaved roads and airstrips	Small reservoirs			Fine aggregate (sand)	Coarse aggregate (gravel)	Fill
Basal till	M	D	D	P	D	D	D	D	D	drainage, boulders	-	U	U	D–P
Ablation till	gM	D	D	P	U	U	D	D	U	boulders, topography	-	U	P	D–P
Floodplains	Fp	D^{HC}	U	D^{C}	U	U	D	D	P	drainage, high water table	floods and shifting channels	P^{C}	D^{C}	D^{C}
	Fv / Fp	D^{HC}	U	D^{C}	U	U	D	P	P			P^{C}	P^{C}	D–P^{C}
Alluvial fans Glaciofluvial fans	Ft Gf	D^{H}	P^{H}	D	U	U	D	D	U	drainage, boulders	shifting channels and floods	U	D–P	D–P
River terraces Glaciofluvial terraces	Ft Gt	D	D	D	U	U	D	D	U	-	-	P	D	D
Other glaciofluvial terrain units*	G	D	D	D	U	U	D	D	U	topography	-	P	P	D–P
Glaciolacustrine materials	L	D^{H}	U	D	P	D	P	P	P	drainage, erosion	slumping, collapse and erosion	U	U	U
Landslide debris	xC	D–P^{H}	U	P	U	U	P	P	U	large blocks, topography	landslides	U	U	P
Talus slopes	Ca, Cc	D^{HC}	U	P	U	U	D^{C}	D^{C}	U	slope	rockfall, avalanches	U	U	P
Colluvial fans	Cf	D^{H}	D^{H}	D–P	P	P	D^{H}	D^{H}	P	-	debris flows	U	P	D
Colluvial mantles	Cv, Cb, Cx	D^{SC}	D^{S}	D^{S}	P	P	P	D	P^{S}	slope, shallow bedrock	avalanches	U	P	D
Eolian mantles	Ev,Eb	D^{S}	P^{S}	D	P	U	P^{S}	D–P	P^{S}	dust,surface erosion	-	P	U	U
Organic materials (undrained)	O	U	U	P	U	U	U	U	U	drainage, subsidence, frozen ground	-	U	U	U
Lava flows	xV	U	U	D–U	U	U	D	D	P	large blocks	-	U	U	P
Cinders	gV	U	U	D	U	U	D	D	U	-	-	U	U–P	P
Volcanic ash	V, sV	D^{S}	D^{S}	D	U	U	D^{S}	D	U^{S}	dust,surface erosion	-	P	U	P
Bedrock	R	D–P	D–P	U	U	U	U	U	U	topography	-	U	U	U

D = desirable, P = possible problems, U = undesirable, H = significant hazard, C = significant constraints, S = see underlying material (applies to any veneer),
* = includes eskers, glaciofluvial deltas and meltwater channels on terrain features map

4. GEOLOGICAL PROCESSES AND POTENTIAL HAZARDS

Geological processes such as are shown on the terrain materials map (legend Box 5) are those that effect erosion, transportation, and deposition of earth-surface materials. Strictly speaking, these are "geomorphological processes" because they influence landforms. The term "geological processes" includes changes that go on beneath the earth's surface, such as metamorphism. Of these, volcanic activity and seismic effects (earthquakes) are potential hazards. These are not indicated specifically on the terrain maps, but volcanic hazards are discussed briefly below (Section 4.8).

Most geological processes are not actually visible, but their effects are evidenced by such features as scars or gullies where material has been eroded, tracks or channels where material has been transported, and accumulations of sediment where deposition has occurred. It is chiefly the former two types of features that provide evidence - on air photos - for the mapping of active geological processes. However, surficial deposits provide evidence of processes also. Thus both the material and process parts of a terrain unit symbol should be considered in any interpretation of geological hazards. For example, the process of rockfall is implied by "-R" in terrain units such as "Rs-R", and also by the presence of rockfall deposits in the form of talus slopes in units which include "Ca". Only processes are discussed in this section of the report. Processes and hazards implied by surficial materials have been described in Section 3 and Table 1.

The terrain materials map shows geological processes in terrain units only where effects are particularly apparent (eg. visible on air photos or from the air), in order to avoid lengthy terrain unit symbols. Terrain types where certain processes are operating but may not have been mapped are indicated in the following descriptions. Where more than one geological process is shown in a terrain unit symbol (eg. Rs - AVR), they are written in order of importance as judged by their visible effects on the land surface.

For land use planning purposes, areas with geological hazards are best avoided: protective measures (eg. dykes to divert debris flows, avalanche warning systems) may be impossible or impractical, or at best are likely to be very expensive.

4.1 FLUVIAL PROCESSES Map Symbols "-M", "-I", "-J", and "-B"

These process symbols can be used to indicate the behaviour of rivers that have floodplains. They are applied only to terrain units that are (or include) floodplains (Fp) and/or alluvial fans (Ff). They refer to the pattern that is made by the river channels, such as is visible on maps and air photos. This is a direct result of long term passage of water and sediment.

4.1.1 Meandering Channels "-M"

Description: Channel characterized by a regular pattern of bends with roughly constant amplitude and wave length. The associated floodplain may display old meander traces or a scroll pattern (concentric series of meander traces). River may be bordered by levées.

Distribution and Examples: Pitman River and portions of Klappan River.

Interpretation and Hazards: Meandering rivers tend to have a relatively low longitudinal gradient, and their sediment load is carried predominantly in suspension. The channel shifts sideways acrosss the floodplain due to bank erosion on the outside and downstream part of bends and deposition of point bars on the opposite side of the river. During floods, bank erosion may occur rapidly and narrow necks of land between adjacent meanders may be breached. Major dislocations of the channel are unlikely to occur. Floodplains may be inundated by standing water during floods.

Associated Materials: Chiefly sand and silt. Deposition of suspended load during overbank floods give rise to floodplain veneers of horizontally bedded silt and sand (see Section 3.2 and Figure 7). The presence of such a veneer is an indication that inundation has occurred. Its recency and likely frequency may possibly be estimated from studies of cumulic soil horizons, soil development and maturity, and vegetation.

4.1.2 Irregularly Sinous Channels "-I"

Description: Channel displays irregular turns and bends without regular repetition of similar features. Small side channels, bars (unvegetated) and islands (vegetated) may be present.

Distribution and Examples: Parts of Stikine River, Mess Creek, Schaft Creek and Iskut River.

Interpretation and Hazards: Rivers of this type are probably transporting gravel, sand, and silt. As in the case of meandering rivers, their floodplains are periodically inundated by standing water, and channels shift sideways by bank erosion. In this case however, lateral shifts occur at variable rates due to inhomogeneities in the composition of river banks (the river may be paritally confined by scarps of bedrock and various kinds of surficial material, eg. Stikine River between Telegraph Creek and Chutine), and the effects of sediment delivered from tributary creeks.

Associated Materials: Silt, sand, and gravel: river occupies a gravel-floored channel and floodplain consists of overbank sediments overlying channel gravels.

4.1.3 Anastomosing Channels "-J"

Description: River channel splits and rejoins around many islands. Some channels will be dry at moderate and low flows.

Note: Islands are distinguished from bars by their relative stability (longevity). They bear a mature vegetation cover, usually forest, and their surfaces are relatively high above mean maximum discharge levels.

Distribution and Examples: Lower Stikine and Iskut Rivers, part of upper Mess Creek.

Interpretation and Hazards: All channels will be occupied by flowing water during floods. Islands and floodplains will be inundated on rare occassions. River channel may shift abruptly to a different course (avulsion) during major floods.

Associated Materials: River occupies a gravel-floored channel. Silts and sands overlie gravel beneath floodplain.

4.1.4 Braiding Channels "-B"

Description: A broad plain or low-angle fan of gravel and sand is covered by many channels which diverge and converge around bars. Many channels are dry at moderate and low flows. Vegetation is absent or limited to early successional stages.

Distribution and Examples: Scud River, upper Schaft Creek, Forrest Kerr Creek, Jeckill River, More Creek and parts of the Stikine and Iskut Rivers; common within Coast Mountains and Spectrum Range; includes alluvial fans (Ff) whether or not they are shown with braiding channels (-B).

Interpretation and Hazards: Rivers and creeks of this type are transporting large amounts of bedload (gravel and coarse sand), although considerable suspended load may also be passed through the system. Usually the source of the bedload is apparent (either rapid mass wasting of slopes

or glacial outwash). The longitudinal gradients of these rivers are relatively steep, and they are subject to wide fluctuations of discharge.

Braided rivers are laterally unstable and channels are commonly subject to avulsions (abrupt shifts to entirely new courses). Channels and bars typically shift their positions during floods. During major floods, the entire plain or large parts of the fan may be covered by shallow but rapidly flowing water. Gravel and sand may be accumulating and slowly raising the level of bars and channels.

The active channel zone may be bordered by areas of relatively stable and rarely inundated, forested floodplain or fan.

Associated Material: Active channel zone consists of gravel and sand. Adjacent floodplain, if present, is underlain by a veneer or blanket of overbank sediments and eolian sediments, and these in turn rest upon channel gravels.

4.1.5 Glacier Outburst Floods (Symbol on terrain features map)

Many lakes that are dammed by glaciers drain catastrophically from time to time. This occurs when the lake outlet becomes rapidly enlarged due to either floatation of the ice barrier, or melting of a tunnel through the ice, or other causes. Exceptionally severe and sudden flooding may occur along rivers downstream from glacier outbursts. In Stikine - Iskut area there are three glacier dammed lakes that are known to be sources of outbursts floods.

Flood Lake discharges down the short Flood River into Stikine River. Its recent history is comparatively well known. In 1889, G. M. Dawson noted that "... a great rush of water occurs almost every year toward the end of summer... The quantity of water thus liberated is so great as to raise the

river [Stikine River] from a low stage to half flood level for a short time." (Dawson, 1889, p. 53B). Forrest Kerr (1948) indicated that the last event of this sort took place in 1918, and there does seem to have been a long interval when no floods were recorded. However, Mokievsky-Zubok (1980) describes an outburst that occurred during August 1979, and notes that a flood also occurred during the mid-1970's. The lake also drained suddenly during the summer of 1982 (see below). In general, Flood Lake should be considered "active" at present, although it may not drain every year. Short-lived but severe floods should be expected in late summer on Stikine River downstream from Flood River.

The second ice-dammed lake is ponded by an unnamed glacier. The lake lies 8 km east of lower Scud Glacier and 9 km northwest from Mt. Hickman. Its discharge flows for 8 km beneath the glacier and then emerges into a tributary of Scud River. Perchanok (1980) suggested, as a result of air photo interpretation, that this lake drained suddenly in 1965. It also drained during summer 1982 (see below). No other observations are known to the writer, so that the frequency of glacier outbursts at this site is unknown. The possibility that this lake may drain annually and cause flooding along Scud River should not be overlooked.

Both of the lakes described above were observed from the air by the writer on September 18, 1982. Both appeared to have emptied (or partially emptied) recently since numerous icebergs were stranded between the actual lake level and an obvious, higher shoreline. The drop in water level (measured by helicopter altimeter to $\pm$ 10 feet or 3 metres) that had occurred at Flood Lake was 250 feet (76 m) and at the unnamed lake, 160 feet (49 m). These figures indicate that a large volume of water had been discharged, but it is not known if drainage occurred rapidly enough to produce notable floods on rivers downstream. Some large gravel bars, well above river level, were present along the unnamed tributary close to its confluence with Scud River. No clear evidence of a recent flood was seen at Flood Glacier, although Flood River had several dry channels that could have been recently occupied.

A third glacier lake is (or was) located at the head of the middle tributary of More Creek, 8 km northwest of observation site TC 82. Perchanok (1980) indicates that this is an active lake - "Natavas Lake" - and that outburst floods occurred in 1965, 1978, 1979, and 1980. J. G. Souther (personal communication, 1983) recalls that this lake drained suddenly in 1961 whilst a field party, dependent upon float plane transportation, was camped nearby! However, no lake is visible, nor are there any icebergs in the basin, on the 1974 air photos that were used for the current project. The lake basin was observed from the air by the writer on September 19, 1982. It was dry and did not appear to have been recently occupied. Thus the present status of Natavas Lake is not known.

A fourth glacially dammed lake existed until recently in an unnamed tributary of the Iskut River, west of Forrest Kerr Creek. Due to glacial retreat, this lake drained. In the event of a glacial re-advance, this lake could again become active.

A reconnaissance survey of all glacier-dammed lakes and potential (eg. should minor glacial readvance occur) glacier dammed lakes was carried out by Perchanok (1980) based on air photo interpretation and analysis of existing hydrological information. His report provides a description of each lake, both actual and potential, and an estimate of the magnitude of possible floods.

Glacier-dammed lakes that give rise to potentially hazardous floods have been described from elsewhere in the Coast Mountains and other glacial areas. Of local interest are Tulsequah Lake, 190 km northwest of Telegraph Creek settlement (Marcus, 1960; Souther, 1971) and Summit Lake near Stewart (Gilbert, 1972). Floods from these lakes threaten local mine roads and settlements. A general description of glacier outburst floods, which are commonly known by their Icelandic name - "jökulhlaups" - and further references are given by Young (1977).

4.2 PERIGLACIAL PROCESSES Map Symbols "-C", "-S", "-N", and "-Z"

These processes and their effects are to be found in all areas above timberline. Relatively severe climate, high frequency of freezing and thawing, humid conditions, and lack of deep and binding root systems combine to produce distinctive land surface features.

Map users should note that these process symbols were placed on the map only where periglacial effects are particularly well expressed.

4.2.1 Cryoturbation "-C"

Description: Heaving, churning, and other movements that result from repeated freezing and thawing of moist, unconsolidated sediments. Gives rise to small hummocks (eg. turf hummocks, frost boils), patterned ground (eg. sorted circles, stone stripes), frost-heaved rock fragments, and convoluted soil horizons.

Distribution and Examples: Effects of cryoturbation, including patterned ground, are common on plateaux in the northern part of the area.

Interpretation and Hazards: Frost heaving and churning of surface material is a constraint to land use, rather than a hazard. Special design and layout of buildings and roads, and special care during construction and operation are required in order to ensure sound foundations and avoid land surface degradation.

Associated Materials: Mantles of weathered bedrock (colluvium), till, and volcanic materials are modified by cryoturbation.

4.2.2 Solifluction "-S"

Description: Slow downslope movement of moist or saturated, seasonally frozen, unconsolidated material over a relatively impermeable substrate

of bedrock or frozen ground. Gives rise to numerous low, lobate mounds and irregular terraces on hillsides, and sheets of slow-moving rock debris. Rates of movement are between a few millimetres and a few centimetres per year.

Distribution and Examples: Common on gentle and moderately sloping terrain above timberline.

Interpretation and Hazards: A severe constraint rather than a hazard. See comment under cryoturbation.

Associated Materials: Mantles of colluvium, till, and volcanic materials.

4.2.3 Nivation "-N"

Description: Erosion and enlargement of hollows containing snowpatches due to a combination of freeze-thaw processes, physical and chemical effects of meltwater, solifluction, and snowcreep. Gives rise to shallow depressions (nivation hollows). For mapping purposes, small cirques and north-facing bedrock scarps that have been undercut and steepened by "snowpatch erosion", are considered to be nivation features.

Distribution and Examples: Widespread throughout the map area on plateaux and north-facing slopes that are above or close to treeline.

Interpretation and Hazards: On gentle and moderate slopes, this process is a constraint rather than a hazard. See comment under cryoturbation. Steep rock slopes affected by nivation are subject to rockfalls.

Associated Materials: Mantles of till, colluvium, volcanic material, and bedrock surfaces are modified by nivation.

4.2.4 Periglacial Processes in General "-Z"

This symbol is used where cryoturbation, solifluction, and nivation occur within the same terrain unit. Thus "-Z" is equivalent to "-CSN".

4.2.5 Other Periglacial Features

Rock glaciers (Section 5.0), frost-shattered debris, and slope features such as block streams also result from periglacial processes.

4.2.6 Permafrost

Permanently frozen ground is a condition, not a process, but merits brief mention here. Permafrost, of course, cannot be identified from a single observation, although frozen ground found during August or September may well be permanently so.

In Stikine - Iskut area, evidence of frozen ground was found at four sites. Organic sediments near Morchuea Lake (TC 37) at 900 m a.s.l were frozen below 60 cm depth on September 8th, 1982. A palsa bog, a surface feature which indicates the presence of permafrost, was found at TC 52 near Kakiddi Creek at an elevation of about 750 m above sea level. Another was found at SP 20 east of the Stikine River in mapsheet 104H at approximately 1188 m a.s.l. Palsas are small features, hard to identify on air photos at the scale used in this project, and bogs were not extensively scrutinized from the air. It is likely that others exist at similar or higher elevations in this area. Several groups of palsas were found in the Dease Lake map area which adjoins map sheet 104G along its northern margin. The thermal properties of organic sediments are such that they are permanently frozen under climatic conditions where other materials would thaw for part of the year. Thus palsas occur along the outermost fringes (both latitudinally and altitudinally) of the permafrost zone.

Frozen glaciolacustrine sediments were observed at SP 32 near the floor of the Klappan River valley in September 1982 (elevation 884 m a.s.l) a east-facing aspect, wet site. Alley and Young (1978) report several similar observations in the Klappan and Little Klappan River valleys.

Brown (1967, Figure 2) indicates that permafrost is probably widespread at high altitude, (above 4000 feet or 1200 m), in Stikine - Iskut area.

In general then, it is likely that permafrost occurs in all types of material at high elevations, but becomes rarer lower down, until along valley floors, only small pockets of frozen ground exist within organic terrain, or at shaded, moist sites in narrow valleys. Most of the frozen ground at high elevations will simply be bedrock with a temperature of less than 0°C. However, on plateaux, where relatively thick, moist, and fine-textured sediments are present, permafrost should be considered as a constraint on any land surface modification.

4.3 SNOW AVALANCHES Map Symbol "-A"

Description: The rapid downslope movement, by flowing or sliding, of snow, slush, and incorporated rock and vegetation debris. Avalanche paths below treeline are strips of immature, low, and deciduous vegetation that cut sharply through mature forest. Above treeline, avalanche paths are not well marked. In places avalanches may be confined to gullies.

Distribution and Examples: Snow avalanche paths are most extensive and most numerous, and avalanches are most frequent where snowfall is heaviest, namely, within the Coast Mountains. Most avalanches are generated from smooth slopes that are at or above treeline. They run down valleysides and may extend out into flat terrain such as floodplains, or even climb a short distance up an opposing slope.

Interpretation and Hazards: Although avalanche paths appear to be well defined by vegetation patterns, this can be misleading. Unusual weather (amount of snow, wind direction, and temperature changes) may give rise to avalanches that outrun old paths or cut new ones. Avalanche zones should be delimited conservatively. Avalanches were only mapped where a terrain unit is crossed by several small or one or two large paths. Isolated single tracks, not shown on the terrain map, are scattered throughout the area.

Associated Materials: Rock and wood debris transported by avalanches may accumulate to form cones or mantles of colluvium (Cc-A, Ca-A, Cvb-A). Avalanches may also cross till or bedrock or other materials without effecting any deposition (eg. Mb-A).

4.4 RAPID MASS MOVEMENT Map Symbol "-R"

Description: Downslope movement of weathered bedrock or other surficial material that is sufficiently rapid to be very obvious to a casual observer. Material may be dry, moist, or saturated, and it may travel by falling, sliding, or flowing. Rockfalls (including small rock slides) and debris flows (including related phenomena) are the two chief types of mass movement included here. Sites where these processes are active are marked by fresh scars, tracks, and debris accumulations.

Rockfalls originate mostly from steep rock outcrops along the upper parts of valleysides. Most rockfalls are probably of relatively small volume, one or a few detached blocks of bedrock which are broken by impacts into smaller fragments as they descend. This falling rock debris may become trapped in gullies or it may accumulate as talus slopes or cones on more gently sloping terrain (hence "Rs.Ca" terrain units). The symbol "-R" is applied where the presence of fresh scars on rock faces or fresh talus debris indicates that this process is active at the present time.

Rockfalls of greater magnitude appear to sometimes travel to beyond the foot of talus slopes. Accumulations of large blocks, occupying areas of between 2500m^2 and 250 000m^2, were noted at several sites in granitic mountain areas. (They are too small to distinguish individually on the terrain materials map.) The sources (eg. scars) of these larger rockfalls were generally not apparent; few are recent events. One example is indicated by a landslide symbol at the head of Missusjay Creek (Ŕr on the terrain features map).

Debris flows originate chiefly from colluvium-covered slopes and from gullies in bedrock where rockfall material and other weathered rock debris accumulates. Less commonly, debris flows are generated from gullies in till. The symbol "-R" was applied to terrain units only where evidence of the recent occurrence of debris flows was seen.

Distribution and Examples: Rockfalls and debris flows occur on slopes throughout the map area. Within local areas, their distribution is controlled by topography (rockfall) and availability of debris (debris flows). Distribution does not appear to be related to bedrock characteristics, although the morphology of mountainsides affected by rapid mass movement does appear to be controlled by bedrock. This was not studied in detail, but some examples can be described here.

Steep mountainsides in plutonic rocks commonly have rather regular gully systems that are probably joint controlled. Falling rock, snow avalanches, and lower down, debris flows, are channelled through these gullies, and regularly spaced debris cones are constructed at their feet. The northern valleyside of Donnaker Creek is a particularly good example (Rs/Ccv - RAV).

In the Spectrum Range and Edziza area, slopes are dominated by horizontally bedded volcanic rocks. Along many scarps, massive slumps have occurred (see Section 4.5), but elsewhere, long, regular talus slopes

have developed below rock escarpments. Examples are found in the central Spectrum Range near the lake at the head of Little Iskut River (Ca/Rs - R) and at Raspberry Pass (Cva.Rs - RAF).

Weathering of interbedded "hard" and "soft" sedimentary rocks in the Skeena Mountains produces fretted mountainsides. The protruding steep edges of harder strata show patterns which reflect geological structure. Softer strata are masked by colluvium and constitute short, gentle slopes. Shallow gullies run directly downslope across these patterns. Some snow avalanches, rockfalls, and sliding debris move down gullies, but elsewhere they travel over open slopes. The south-facing valleysides of Devil and Thomas Creeks are examples (Rs.Cva - RA).

Interpretation and Hazard: Rockfalls and debris flows obviously constitute hazards, particularly to settlement and other forms of land use that involve continuous human occupancy.

Steep rock faces (Rs), talus slopes (Ca and Cc), and evidence of recent falls (-R) indicate, in increasing order, the increasing likelihood of future rockfall. The possibility of major (large volume) rockfalls or slides is difficult to predict. A thorough investigation of slope stability should be carried out in the vicinity of any site where settlement is planned in steep terrain (see also Section 4.5).

Sites affected by debris flows are indicated, to a large extent, by the presence of debris flow tracks (-R), gullies in colluvium and drift (eg. Cb - V, Mb - V), and debris flow fans (Cf). Debris flows may also occur unexpectedly at other sites. For example, they are sometimes generated during heavy rainstorms by small slumps in till or colluvium on moderately steep hillsides. The distance likely to be travelled by a debris flow, even on a known debris fan, is hard to estimate. Debris flows that enter steep stream channels may continue for several kilometres.

Associated Materials: Colluvium and bedrock. (See descriptions above.)

4.5 SLOW MASS MOVEMENT: LANDSLIDES Map Symbol "-F" and also symbols on terrain feature map.

General Description: Unconsolidated material and dislocated bedrock in large masses moving slowly downhill by flowing and/or sliding. The resulting landslide deposit (debris) has irregular hummocky or ridged topography amongst which seepage zones or small ponds may be present. It is bounded upslope by either an arcuate scarp or a "spoon-shaped" depression which marks the site where rupture occurred (the landslide scar); its lateral margins may be marked by ridges (levées), and the downslope margin (toe) is typically a steep, convex slope.

For mapping purposes, the results of slow mass movement are considered to be the landslides of various kinds that are indicated on the terrain features map. Some of these may have undergone rapid or pulsatory movement, but slow displacement is suggested for most because debris has only travelled a short distance down the slopes where it originated. The following descriptions are based upon the classification of landslides that is given on the terrain features map. In this report, "landslides" is used as a general term to include slumps and slides of various kinds, and earthflows.

4.5.1 <u>Landslides in Surficial Materials</u> "U" on terrain features map

Small landslides have occurred in till, and both small and large slides have occurred in glaciolacustrine sediments. Slope failures of this kind take place on scarps that have been cut in drift during postglacial time by stream and river erosion, including steep slopes along the edges of floodplains, terrace scarps, and the sides of narrow canyons and inner valleys.

Slides and slumps in till give rise to rounded embayments, that are shaped like cirques, along drift scarps. Where slide scars are close

together, scarps have a scalloped appearance. Gullies that head back from these scarps and that have rounded (rather than pointed) upper ends, may have been formed by retrogressive (repeated) slumping. Slide debris is commonly absent from these sites. Presumably it slid onto the floodplain or into the river and was removed by fluvial erosion. Good and relatively large examples of these features are to be found along lower Mess Creek (see terrain features map). Numerous small slides and slumps in till (too many and too small to map) have occurred along the banks of streams and rivers throughout the area.

Slumps caused by failure of glaciolacustrine sediments are common within all terrain units where this material is present, including those where silts and clays are overlain by till or other surficial material. These slides are generally marked by an arcuate slide scar, and tilted and downdropped but still somewhat coherent masses of displaced silt and overlying sediments (Figure 8). A good example of an "active" slump of this type is located in Iskut River Valley on an unnamed creek, 3 km south of Ball Creek (marked "U_{np}" on the terrain features map). A second example, an apparently very actively retrogressing slump-earthflow in which glaciolacustrine clay is involved, is located in Iskut River valley near Eastman Creek (U_n). Glaciolacustrine silt may also be present in some of the Mess Creek Valley landslides and in small (unmapped) slides in Stikine River Valley near Telegraph Creek. Slumps and slides in glaciolacustrine silts are common in the Stikine-Klappan River lowland, and a number of these are very large and still moving.

Two important factors control slope failure in till and glaciolacustrine silt: (1) steep slopes, probably undercut by fluvial erosion only a short time before slumping occurs, and (2) a groundwater condition such that high pore water pressures are induced in silt or till, resulting in loss of cohesion and failure. Where seepage of groundwater occurs at the ground surface, particularly on scarp slopes, then this latter condition may exist. Heavy rain, rapid river erosion during floods, and earthquakes likely trigger these landslides.

4.5.2 Landslides in Tertiary and Quaternary Volcanic Rocks "V" on terrain features map

Some of the largest landslides in the Stikine - Iskut area, and probably also the oldest, have occurred along the high escarpment that bounds the western edge of Edziza plateau and its counterpart in the Spectrum Range. (See terrain features map for locations.) Landslide scars are continuous over long stretches of the cliffed upper part of the main escarpment and its continuation in the canyons of Elwyn, Taweh, and Raspberry Creeks and unnamed canyons in the Spectrum Range. Lower slopes are underlain by irregular landslide debris. On many parts of the lower slope of the main escarpment, local relief is subdued, although old slump blocks are faintly discernible. Ridges that are levées of an old, very large slump-earthflow are present to the northeast of Mess Lake (J. G. Souther, pers. comm., 1983). Subdued areas are interpreted as very old, probably pre-Fraser Glaciation landslides. They are shown as "V_g" and $\frac{\text{"M"}}{\text{xCh}}$ on features and materials maps respectively.

Large landslides with distinctly fresher topography, in which slump blocks, pressure ridges, and secondary slide scarps are clearly visible, are located chiefly in the valleys that dissect the Edziza plateau. Slide debris is well vegetated and fresh rock surfaces generally not apparent. Hence these are supposed to be postglacial but relatively old features. They are mapped as "V_o" and "xC..." on the features and materials maps respectively. "xCrha/Rs - FR" (materials map) in the basin of Raspberry Creek is a good example.

Recent and new (eg. V_r and V_n) landslides, where slope movement may still be occurring along these escarpments, are comparatively small features. Many are located along the crest of the Edziza escarpment, but others are reactivated zones in the old debris. Some examples are indicated on the terrain features map, but many are too small to be shown.

The failure plane of the old, large landslides probably lies deep within the strata of the old shield volcano (Section 2.4). This is suggested by the absence of major slides along the steepsided but shallower valleys, such as those of the Taweh Creek System, and the location of the most recent major slides along the deeper V-shaped valleys where rapid downcutting has occurred relatively recently. Souther (1972) indicates that the lower part of the shield volcano is a sequence of basalt flows separated by loose scoria and ash. Failure probably occurred in the pyroclastic materials, and detachment of slide masses was aided by well developed vertical jointing in the basalts. Earth tremors associated with volcanic activity are a possible trigger mechanism.

Large, old landslides (V_g) in the headwater valleys of Little Iskut River, near TC 60B, probably have a similar origin to those of the western escarpment.

Other landslides in volcanic rocks are scattered throughout the area between Coffee Crater and the southern end of the Spectrum Range. In the Spectrum Range, some landslide scars are coincident with cirque headwalls, and some debris deposits appear to be of mixed morainal and landslide origin. Surprisingly enough, landslides were not identified on the steep, eastern side of the Edziza massif.

Major landslides are present on Hoodoo Mountain. Kerr (1948) reports that a major slide occurred on the west side of this volcano in 1919.

4.5.3 Landslides in Other Bedrock "R" on terrain features map

Landslides in sedimentary and older volcanic rocks have occurred at scattered locations. Only two slides were recognized in granitic rocks, although several large rockfalls were identified (Section 4.4). Most of these landslides are relatively old features. Four of them merit individual descriptions here.

A large, old landslide that appears to be still slowly moving is located about 4 km east of the northern end of Yehiniko Lake ("R_p or R_p?" on the features map). The slide has a well defined, gullied headscarp; the upper part of the sliding mass is crossed by several other scarps and tension cracks which are expressed topographically as gullies. The toe of the slide is bounded by an unnamed creek. Along the opposite (eg. northern) side of this creek there is a fresh scarp, presumably a result of recent undercutting. It is this asymetric erosion that strongly suggests slow movement of the slide mass. This area is underlain by sedimentary strata. Slope failure is occurring in weakly consolidated conglomerates (J. G. Souther, pers. comm., 1983).

A recent rockslide that probably moved rapidly has occurred near the head of the unnamed creek 4 km south of lower Ball Creek (R_r and xCh). This slide postdates the "Little Ice Age" glacier maximum of the eighteenth and nineteenth centuries since its debris has obliterated the recent lateral moraine of an adjacent glacier. Small collapse features in the slide debris suggest that it may have descended onto the receding glacier.

Two large landslides along the northern side of More Creek are shown on the terrain features map (R_g?). They were identified from topographic evidence: the steep, slightly embayed upper valleyside represents the slide scarp of the larger slide; extensive hummocky topography with a small lake $\frac{\text{"Mw"}}{Rh}$ on the material map) represents the landslide debris. This latter type of terrain extends further west than the supposed slide scarp, however, and the size of the whole feature is so large that the writer has an equivocal opinion of this interpretation.

Large tension cracks are common in steeply dipping sedimentary strata high on the north and south valley walls of Todagin Creek, suggesting that major landslides may occur here in the future. A recent, small landslide that ran down to Kluea Lake was observed at SP 27 in this valley.

4.5.4 Interpretation and Hazards

Little can be added that has not already been implied in the descriptions above. Many landslides in this area occupy "typical" locations that can be categorized and then recognized wherever they occur (eg. undercut scarp slopes in till). Others, however, appear to be randomly distributed, at least at this reconnaissance level of survey. Since it is unfeasible to make a detailed study of all landslides and all potential landslides in this area, it is recommended that slope stability be specifically investigated in the general vicinity of any sites where either settlement or other form of human occupancy, or major construction, is planned.

4.6 GULLYING Map Symbol "-V"

Description: The formation of long, narrow depressions due to erosion by one or more of running water, mass movements, and snow avalanches. Gullies may have either steep or gently sloping sides, and either steep or gently sloping longitudinal profiles. They were mapped where their presence is not adequately shown by the contours of the topographic base map.

Distribution, Examples, and Associated Materials: Gullies are most common on steep moutainsides of bedrock and colluvium (see terrain materials map for numerous examples; see Section 4.4). They are especially well developed in canyons cut into predominantly shale and siltstone bedrocks in the Skeena Mountains east of Snippaker Mountain in mapsheet 104B. Volcanic (pyroclastic: gV, sV, and fV) sediments appear to be very susceptible to gullying, and thus are probably the most easily eroded by running water of all the surficial materials of the Stikine-Iskut area. They are gullied on moderate slopes on the northeastern edge of Edziza plateau (eg. $\frac{sVvh}{Mb}$ - V) and elsewhere. Some till mantles (Mv,Mb) on moderately sloping hillsides have been modified by gully formation, particularly where they are crossed by avalanches (eg. Mb -AV).

Steep, short gullies are common along the scarps of entrenched rivers in till, glaciolacustrine sediments, some types of bedrock, and less commonly, in glaciofluvial sediments (eg. Us - V).

Interpretation and Hazards: The distribution of gullies in the various materials of the area can be used as a very rough guide to their relative erodibility. Of course, other factors also influence gully formation, such as slope steepness, surface or subsurface runoff or other effects (eg. avalanches) delivered from upslope, and structural weaknesses in bedrock.

Where the "-V" is the only geological process shown in a terrain unit, then the process of erosion is unspecified. Where other processes are indicated (eg. Rs/Ca - ARV) then they likely contribute to gully enlargement.

Debris flows commonly originate from gullies where weathered material accumulates and is then flushed out during heavy rain or snowmelt. Repetition of these processes results in construction of debris flow fans (Cf - if large enough to map).

4.7 GLACIAL MELTWATER CHANNELS Map Symbol "-G"

Description: Small, discontinuous valleys and gullies eroded by meltwater during ice recession at the end of Fraser Glaciation. Meltwater channels in drift have gentle to moderately sloping sides and flat floors. Channels in bedrock tend to be comparatively deep and narrow. Channel floors may be underlain by glaciofluvial gravel and sand, but they tend to be poorly drained, and they may contain organic sediments and small lakes.

Distribution and Examples: Some meltwater channels are present in most till and glaciofluvial gravel terrain units in lowland areas and in Buckley Lake uplands, and scattered examples occur on plateaux. Good examples

are present near Morchuea Lake in drift, and near the Chutine-Stikine confluence in bedrock. Numerous well defined meltwater channels are evident on the surface and flanks of the northern Spatsizi Plateau. Only larger meltwater channels are shown on the terrain features map.

Interpretation: Small deposits of gravel and sand that occur along meltwater channels may be useful sources of aggregate material. Since meltwater channels are relict features, they are not hazardous.

4.8 VOLCANIC HAZARDS (Not on map)

The possibility of future volcanic eruptions in this area has been addressed by Dr. J. G. Souther of the Geological Survey of Canada (Souther, 1981). He points out that since volcanic activity has occurred very recently within the Stikine volcanic belt, which includes the well known Aiyansh flow (Nass Lava Beds) north of Terrace, the possibility of future eruptions from centres of sporadically repeated vulcanism such as Edziza, Spectrum Range, and lower Iskut Valley cannot be ruled out. The impact of such an event, should it occur, will depend upon its location and the type of material erupted.

Basaltic lavas are the most likely product of any future eruption. These tend to erupt passively, rather than explosively, and form slow-moving lava flows that move down existing valleys. Lava fountains near the vent may build a cinder cone, and a small amount of airborne ash may be deposited downwind. "The most serious impact of such an eruption would probably arise from disruption of the local drainage system, formation of unstable lava dams, or excessive melting of glacier ice, any of which could lead to downstream flooding". (Souther, 1981).

The history of vulcanism in this area is relatively well known as a result of Dr. Souther's work. Further site specific studies, including monitoring of microearthquakes, are being carried out by British Columbia Hydro engineers and geological consultants.

5. THE TERRAIN FEATURES MAP

This map shows a variety of features that are not shown or not adequately distinguished on the terrain materials map. They are briefly described and their significance is stated in the following notes:

Drumlins: Streamlined hills of till or till over a rock core; indicate the alignment of ice flow (eg. northwest - southeast), but not necessarily the direction toward which it was moving.

Crag and tail: Streamlined hills consisting of a rock knob with a "tail" of till pointing in the same direction as ice flow.

Striae (striations): Scratches on bedrock made by stones held in moving ice; indicates alignment of ice flow.

Lineations: Includes all of the above and other elongate features which formed parallel to ice flow.

Moraine ridges of the "Little Ice Age": The outermost of the fresh moraines that lie close to the terminii of modern glaciers; indicates the extent of glaciers during the eighteenth and nineteenth centuries.

Eskers: Glaciofluvial gravels deposited by streams that flowed within or beneath ice; commonly a useful source of aggregate material.

Meltwater Channels: See Section 4.7; only relatively large examples are shown on the features map.

Glaciofluvial deltas: Built by meltwater streams entering glacial lakes; commonly a useful source of aggregate material.

Ice-contact scarps: Where a glaciofluvial delta or other depositional feature abutted against a glacier during its construction.

Cirques: Large, rounded hollows with steep sides and headwall that form at the heads of glaciers; may contain glaciers at present.

Arêtes: Knife-edged ridges with a cirque on either side.

Ice-divides: Drainage divides of glaciers.

Modern ice-dammed lakes
Glacier outburst floods } - See Section 4.1.5 (a potential hazard).

Rock Glaciers: Accumulations of rock debris that flow slowly downslope; only relatively large examples are shown on the features map; also shown as "Cr" and "Cm" on terrain materials map; see Section 3.5.

Palsa bogs: Ice-cored mounds in organic terrain; a landform associated with permafrost; (see also Section 4.2.6); examples at TC 54 and SP 20.

Former channel of Stikine River: Old channel bounded on either side by scarps; near Telegraph Creek (not a terrace).

Volcanic cones: Smaller cinder cones on the Edziza plateau and adjacent areas; formed by eruptions since Fraser Glaciation.

Sackung: Small uphill-facing scarps in bedrock; formed since Fraser Glaciation as a result of slight movements along joint or bedding planes.

Gravel pits: Large pits only; presently active and disused.

Observation sites: Sites where ground observations were made during helicopter traverses, and sites where features were described and materials sampled along roads.

Landslides: See Section 4.5.

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APPENDIX A
AIR PHOTOS USED FOR TERRAIN MAPPING

104G			
BC	5607:	90 to 279	August 17, 1974
BC	5612:	1 to 47	August 17, 1974
104B			
BC	5626:	58 to 190	1979
104F			
A	23874:	187 to 223	1980
A	24218:	182 to 186	1980
A	25238:	58 to 66	
A	25287:	5 to 14	
A	25558:	136 to 141	
104H			
A	20059:	36 to 65	1967
A	20110;	57 to 85	
A	20115:	1 to 28	1979
A	20117:	1 to 20	1979
A	20118:	9 to 12	

APPENDIX B
LABORATORY AND FIELD DATA

The results of laboratory analyses and some field observations regarding texture and Atterberg Limits of selected surficial materials are presented here. Texture (particle size) of the fine fraction (less than 0.06 mm) of sediments was determined by pipette analysis. Texture of sand and fine gravel (less than 8 mm) was determined by sieving. All laboratory analyses were carried out in the Ministry of Environment Soils Laboratory in Kelowna.

B.1 TILL

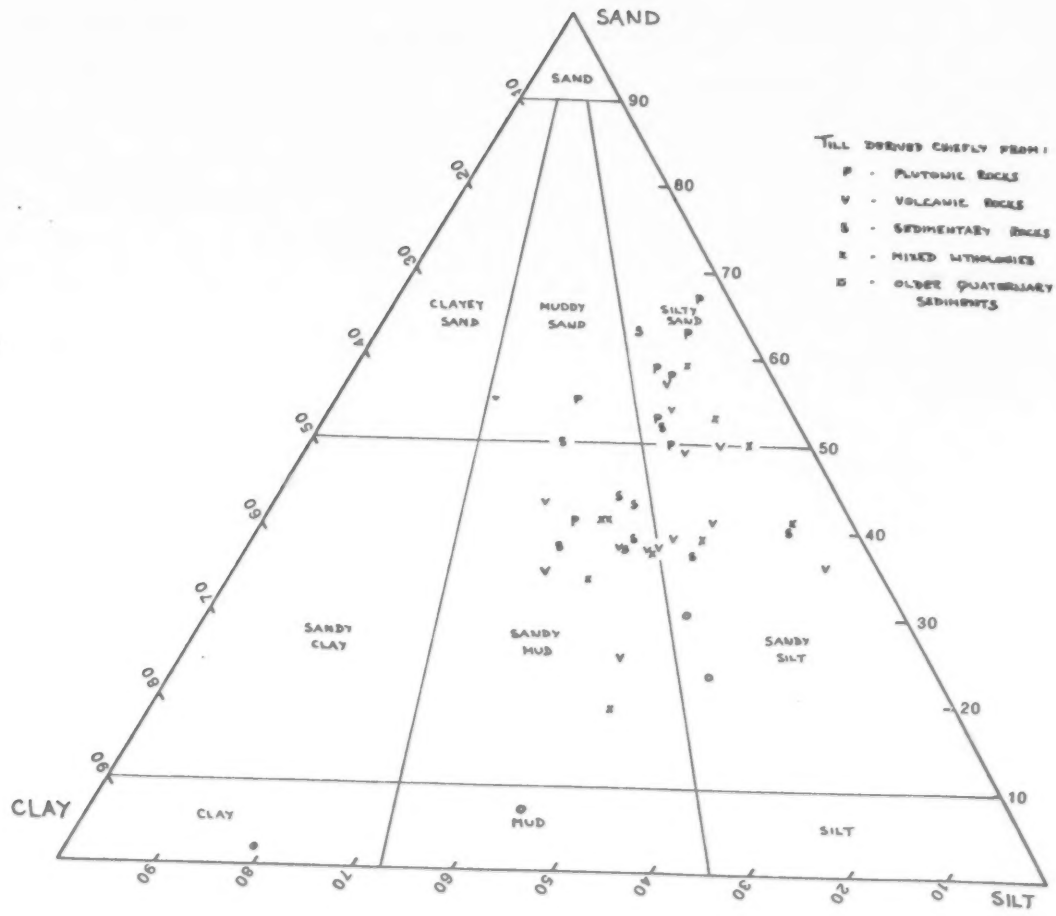

Figure B.1 Textural triangle showing till matrix textures. Note that there is no clear relationship between till texture and the lithology of underlying bedrock. Plutonic rocks do appear to be associated with relatively sandy tills, but volcanic and sedimentary rocks underlie tills with a wide range of texture. See also comments in Section 3.1.

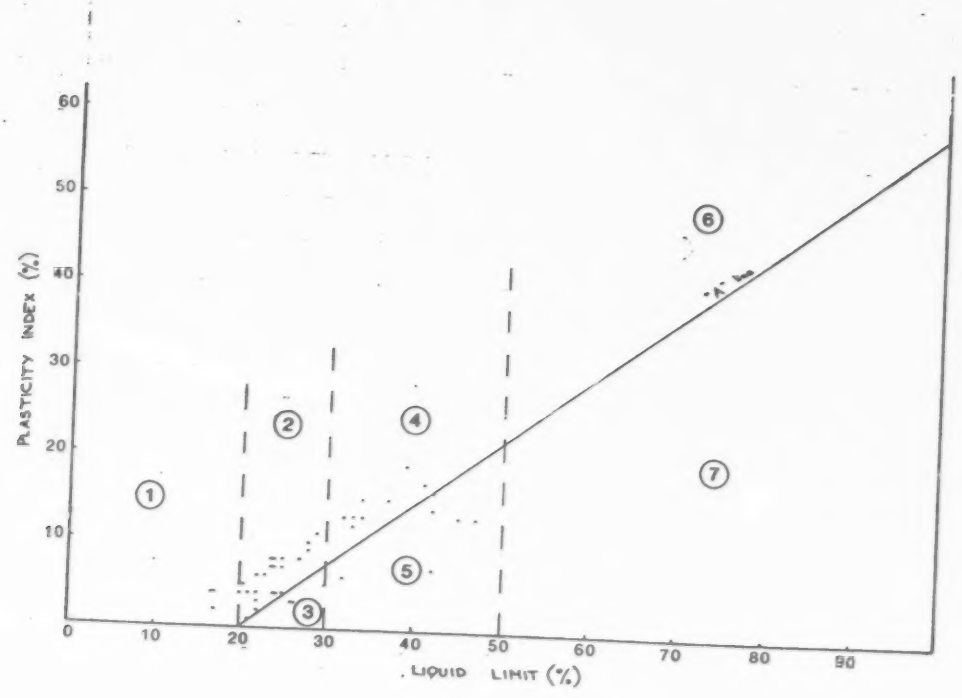

Figure B.2 Plasticity chart (Leggett, 1967; Casagrande, 1948) with data for Stikine - Iskut tills. The "A" line and other straight lines are empirical boundaries that separate sediments with different properties. 1) cohesionless soils; 2) inorganic clays of low plasticity; 3) inorganic silts of low compressibility; 4) inorganic clays of medium plasticity; 5) inorganic silts and organic clays of medium compressibility; 6) inorganic clays of high plasticity; and 7) inorganic silts and organic clays of high compressibility.

Table B.1
Till Data

SAMPLE NO.	SITE NO.	MATERIAL AND/OR LANDFORM	MATRIX*			COARSE FRAGMENTS**			ATTERBERG LIMITS		
			% Sand	% Silt	% Clay	2-8 mm	>8 mm	Chief Lithologies	Plastic Limit	Liquid Limit	Plasticity Index
TC1	TC4	basal till	54	34	12	24	20	andesite, dacite	15	20	5
TC2	TC5	basal till	34	36	30	23	10	andesite, dacite, shale, conglomerate	21	33	12
TC3	TC7	basal till	41	34	25	21	5-30	-	20	33	13
TC4	TC8	basal till	39	38	23	22	20	andesite, conglomerate, sandstone, mudstone	17	24	7
TC5	TC10	basal till	50	25	25	13	20-30	sandstone, conglomerate, shale and others	18	25	7
TC5	TC19	basal till	41	31	28	25	1-5	plutonics, rhyolite, sandstone	19	34	15
TC10	TC30	basal till	63	31	6	31	30-40	plutonics, andesite	17	21	4
TC11	TC31	basal till	41	53	6	12	30	basalt tuff, andesite, argillite	19	22	3
TC12	TC32	basal till	30	48	22	6	10	basalt plutonics	17	24	7
TC15	TC38	basal till	7	43	50	11	<5	basalt	24	41	17
TC21	TC58	basal till	39	42	19	35	50	lavas, tuff, breccia plutonics	16	22	6
TC22	TC608	basal till	36	59	5	34	40	lava, tuff	20	21	1
TC23	TC64	basal till	43	27	30	29	10	volcanic	22	37	15
TC24A	TC65	basal till	44	34	22	15	variable	greywacke, shale, conglomerate	26	32	6
TC25	TC67	basal till	53	33	14	30	-	many varieties	18	25	7
TC26	TC68	basal till	41	34	25	21	20	volcanic plutonics	19	32	13
TC27	TC71	basal till	19	46	35	13	10-20	andesite, plutonics	23	31	8
TC29	TC81	basal till	38	40	22	37	10	volcanics, plutonics	18	28	10
TC30	TC89	basal till	49	38	13	19	30	volcanic	15	17	2
TC33	TC92	basal till	49	38	13	26	-	volcanic	20	24	4
TC31B	TC90	basal till	80	20	0	15	-	volcanic	NP		
IS1		basal till, lowland	43	36	21	22	40	siltstone, shale, greywacke	16	22	6

Table B.1 (Continued)

SAMPLE NO.	SITE NO.	MATERIAL AND/OR LANDFORM	MATRIX*			COARSE FRAGMENTS**			ATTERBERG LIMITS		
			% Sand	% Silt	% Clay	2-8 mm	>8 mm	Chief Lithologies	Plastic Limit	Liquid Limit	Plasticity Index
IS10		basal till, valley side	67	30	3	24	60	quartz monzonite	23	26	3
IS13		basal till, valley side	57	32	11	29	50	breccia, tuff	18	22	4
IS17		basal till, valley side	59	33	8	39	30	matamorphics, plutonics	20	24	4
IS18		basal till, upland	53	39	8	14	10	siltstone	25	30	5
IS19		basal till, valley side	58	32	10	16	30	many varieties	13	17	4
IS21		basal till, upland	37	45	18	25	50	siltstone, greywacke	34	47	18
IS23		basal till	41	45	14	15	60	basalt	26	42	14
IS24		basal till, valley side	40	53	7	17	45	siltstone	19	25	6
IS25		basal till, lowland	55	16	29	21	60	siltstone, greywacke	19	26	7
IS26		basal till, upland	35	31	34	15	35	siltstone	18	29	11
IS28		basal till, upland	55	24	21	31	35	plutonic	32	45	13
SP4		basal till, upland	50	36	14	13	5	granite, schist, andesite	13	17	4
SP3		basal till, valley side	25	44	31	9	5	andesite, dacite	21	34	13
SP4		basal till, valley side	38	37	25	23	20	andesite, basalt	19	27	8
SP7		basal till, plateau	50	41	9	28	25	volcanic	20	24	4
SP10		basal till, upland	50	44	6	31	45	basalt, andesite	35	42	7
SP11		basal till, lowland	39	45	16	19	25	-	16	20	5
SP17		basal till, plateau	38	31	31	17	20	conglomerate	20	39	19

Table B.1 (Continued)

SAMPLE NO.	SITE NO.	MATERIAL AND/OR LANDFORM	MATRIX*			COARSE FRAGMENTS**			ATTERBERG LIMITS		
			% Sand	% Silt	% Clay	2-8 mm	>8 mm	Chief Lithologies	Plastic Limit	Liquid Limit	Plasticity Index
SP20		basal till, plateau	38	40	22	9	30	andesite, basalt	15	20	5
SP21		basal till, lowland	23	54	23	5	15	-	17	24	7
SP22		basal till, plateau	37	38	25	12	40	conglomerate	19	28	9
SP24		basal till, plateau	52	34	14	35	60	conglomerate, sandstone	17	23	6
SP25		basal till, plateau	79	13	8	34	45	basalt	23	26	3
SP30		basal till, upland	63	26	11	37	55	siltstone, conglomerate	17	19	2
SP31		basal till, plateau	59	30	11	36	40	granite	20	22	2
SP40		basal till, lowland	38	41	21	31	50	andesite, basalt	16	24	8
TC13	TC34	ablation till	82	18	-	26	60	many varieties	NP		
IS6		young lateral moraine	57	31	12	27	75	basalt			
IS9		till from cirque floor	61	36	3	31	80	quartz monzonite			
IS14		young lateral moraine	78	16	6	60	45	plutonic, basalt			
IS15		young lateral moraine	78	22	-	38	60	basalt			

*Sand 2 - 0.06 mm; Silt 0.06 - 0.002 mm; Clay less than 0.002 mm.
**Coarse fragments 2-8 mm are % by weight of less than 8 mm fraction of the till.
Coarse fragments >8 mm are % by volume (visual estimate) of total till volume for TC samples, and % by weight (visual estimate) of total till volume for SP, SD and IS samples; figures are approximate only.

Table B.2
Data for Other Surficial Materials

SAMPLE NO.	SITE NO.	MATERIAL AND/OR LANDFORM	MATRIX*			COARSE FRAGMENTS**			ATTERBERG LIMITS		
			% Sand	% Silt	% Clay	2-8 mm	>8 mm	Chief Lithologies	Plastic Limit	Liquid Limit	Plasticity Index
TC7	TC21	Colluvium: fine centre of sorted circle	67	24	9	-	-	basalt	21	23	2
TC8	TC22	Colluvium: fine centre of sorted circle	36	59	5	-	-	schist, basalt	22	25	3
TC27		Colluvium (rCvb) on valley side	18	77	5	14	75	schist	52	58	6
SD1		Colluvium: lobe of recent debris flow	60	30	10	29	65	granodiorite	NP		
SP26		Colluvium: weathered bedrock on plateau	61	27	12	66	60	conglomerate	NP		
SP33		Colluvium: (rCv) on valley side	39	34	27	19	30	andesite, basalt	17	24	7
SP16		Glaciofluvial terrace	75	19	6	26	40	-	21	25	4
TC14a	TC35	Glaciolacustrine sediments	6	48	46	0	0	-	-	-	-
TC14b	TC35		2	66	32	0	0	-	-	-	-
IS5		Glaciolacustrine sediments	5	65	30	0	0	-	28	42	14
SP32		Glaciolacustrine sediments	32	43	25	4	0	-	19	26	7

*Sand 2 - 0.06 mm; Silt 0.06 - 0.002 mm; Clay less than 0.002 mm.
**Coarse fragments 2-8 mm are % by weight of less than 8 mm fraction of the till.
Coarse fragments >8 mm are % by volume (visual estimate) of total till volume for TC samples, and % by weight (visual estimate) of total till volume for IS, SD and SP samples.